ORYX DTS USER MANUAL

CLOSE THE MONITORING GAP

sensornet

CONTENTS

SAFETY 1

GENERAL SAFETY 1
LASER SAFETY 2

INTRODUCTION - SYSTEM OVERVIEW 4

OPTICAL AND ELECTRICAL CONNECTIONS 7

COMMUNICATIONS OPTIONS 11

FRONT PANEL INDICATORS 13

INSTALLATION GUIDELINES 15

PHYSICAL INSTALLATION 15
SOFTWARE INSTALLATION 15

GETTING STARTED 17

THE ORYX DATA COLLECTOR (ODC) 20

SELECTING ROOT & ADDING AN ORYX 20
CONFIGURING THE ORYX 29
THE DATA & LOG FILES 41

GUIDE TO DTS MEASUREMENTS AND THE ORYX CONFIGURATION WIZARD 46

BACKGROUND TO DTS 46
GRAPHICAL USER INTERFACE 49
ORYX CONFIGURATION WIZARD 52

DOUBLE-ENDED MEASUREMENTS 68

INTRODUCTION TO DOUBLE-ENDED 68
CONFIGURING A DOUBLE-ENDED MEASUREMENT 69

THE ORYX DATA VIEWER 74

SOFTWARE INSTALLATION & LICENSING 74
SETTING ROOT & SELECTING AN ORYX 75
VIEWING LIVE DATA 78
VIEWING HISTORICAL DATA 83

CARE & MAINTENANCE 86

© Sensornet 2007

TROUBLESHOOTING **87**

SPECIFICATIONS **89**

PERFORMANCE SPECIFICATIONS 89
OPERATING & PHYSICAL SPECIFICATIONS 90
DIMENSIONS 93
WARRANTY 93

CE

Declaration of Conformity

We, the manufacturer,

Sensornet Ltd
340 Centennial Park
Elstree
London, WD6 3TJ
United Kingdom

declare that the product

ORYX DTS
(Distributed Temperature Sensor)

conforms with the essential requirements of the EMC Directive - **2004/108/EC** and Low Voltage Directive - **2006/95/EC** based on the following EU Harmonsied Standards:

EMCD : 2004/108/EC		**LVD : 2006/95/EC**	
BS EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements	BS EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements
BS EN 55022:1998	Information technology equipment - Radio disturbance characteristics	BS EN 60825-1:2007	Safety of laser products — Part 1: Equipment classification and requirements

The manufacturer also declares the conformity of above mentioned product with the following National & EU Harmonised Standards:

Harmonised Standard		**National Standard**	
BS EN 61000-4-3:2006	Electromagnetic compatibility (EMC) -- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	FCC CFR47 Pt15 Class A	FCC Rules & Regulations Pt15 (USA)
BS EN 61000-4-2:1995	Electromagnetic compatibility (EMC) -- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	ICES-003	Spectrum Management and Telecommunications Policy Interference-Causing Equipment Standard: Digital Apparatus (Canada)

VP Production & Development:

Peter N Kean

Chief Technology Officer:

Dan Watley

This page intentionally blank.

SAFETY

GENERAL SAFETY

The following section provides Warnings, Cautions and Notes covering general safety aspects for the Oryx DTS. Please read all of the safety and operational warnings before connecting and operating this product.

WARNING! THIS IS A WARNING SYMBOL. THIS SYMBOL IS USED THROUGHOUT THE USER GUIDE WHENEVER THERE IS A RISK OF PERSONAL INJURY. ENSURE THAT THESE WARNINGS ARE READ AND UNDERSTOOD AT ALL TIMES.

CAUTION! This is a Caution symbol. This symbol is used throughout the user guide whenever there is a risk of damaging the Oryx DTS system. Ensure that these warnings are read and understood at all times.

NOTES:
Used throughout the user guide to provide additional information, hints and tips.

WARNING! THE ORYX DTS IS HEAVY. ENSURE ADEQUATE CARE IS TAKEN WHEN LIFTING AND MOVING. THE UNIT SHOULD BE MOUNTED ON A SUITABLE SURFACE OR RACK MOUNT CAPABLE OF SUPPORTING THE WEIGHT. THE ORYX DTS WEIGHS 7KG.

CAUTION! Ensure the ORYX DTS is connected to a suitable electrical supply. 12 – 24VDC should be used.

WARNING! ENSURE THE ORYX DTS IS ADEQUATELY EARTHED. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF ELECTRIC SHOCK.

© Sensornet 2007

WARNING! THERE ARE NO USER SERVICEABLE PARTS INSIDE. UNDER NO CIRCUMSTANCES SHOULD THE OUTER CASING OF THE ORYX DTS BE REMOVED. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF ELECTRIC SHOCK.

WARNING! DO NOT OPERATE THE ORYX DTS IN AN EXPLOSIVE OR FLAMMABLE ATMOSPHERE. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF EXPLOSION.

CAUTION! The ORYX DTS should only be operated by suitably qualified personnel.

CAUTION! Never operate the ORYX DTS if any damage is observed. Contact Sensornet Ltd for advice.

LASER SAFETY

The ORYX DTS is a Class 1M laser product.

The ORYX distributed sensing system incorporates a pulsed laser device whose invisible output radiation is potentially hazardous if viewed directly by eye. The laser radiation emission from the laser within the ORYX DTS is permanently coupled into a 50/125 multimode optical fibre whose end is terminated with an APC, angled polished optical fibre connector.

The Oryx DTS should be interfaced to a test fibre, using patch cord or pigtail assembly, fitted with an APC connector. The far end of the test fibre should be terminated to prevent free-space emission of laser radiation from the fibre end. It is recommended that where possible, fusion splices or APC connectors be utilized throughout the optical sensing network.

Because of the potential hazard posed by laser radiation being emitted from an exposed fibre end, the following safety warnings, cautions and notices should be observed.

© Sensornet 2007

WARNING! DO NOT LOOK AT OR EXAMINE EXPOSED FIBRE OR CONNECTOR ENDS WHENEVER THE DTS IS IN OPERATION.

WARNING! AVOID EYE EXPOSURE TO THE INVISIBLE LASER RADIATION EMITTED FROM FIBRE CONNECTORS OR EXPOSED FIBRE ENDS.

WARNING! DO NOT EXAMINE OR INSPECT EXPOSED FIBRE OR CONNECTOR ENDS USING A VIEWING AID SUCH AS AN EYE LOUPE OR MICROSCOPE WHILE POWER IS APPLIED TO THE DTS.

WARNING! DO NOT UNDERTAKE FUSION SPLICING OR SIMILAR FIBRE JOINTING WHEN THE DTS IS IN OPERATION.

WARNING! THE DTS SYSTEM CONTAINS NO USER SERVICEABLE PARTS AND THE PROTECTIVE HOUSING FULLY ENCLOSES A CLASS 3B (EMBEDDED) LASER DEVICE. UNDER NO CIRCUMSTANCES SHOULD THE PROTECTIVE HOUSING BE REMOVED.

© Sensornet 2007

INTRODUCTION - SYSTEM OVERVIEW

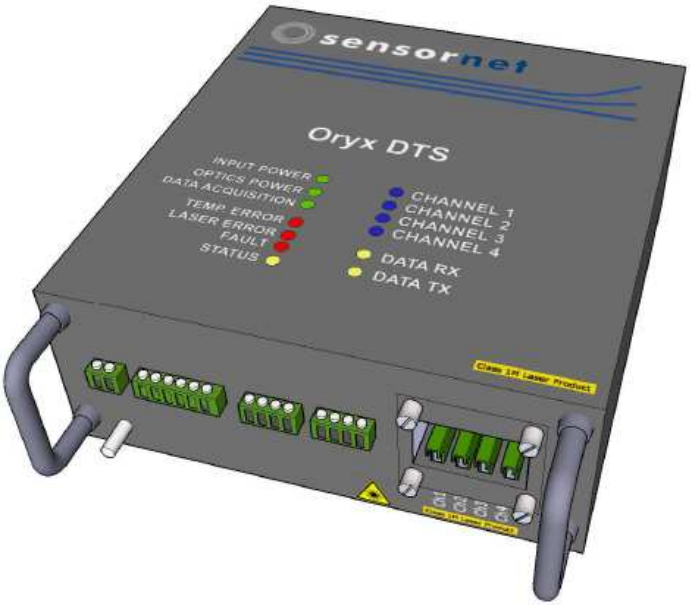


Figure 1 - The Oryx DTS

The Sensornet ORYX DTS unit is an intelligent remote logging unit for collecting fully distributed temperature data over installed fibre optic cable. The device will autonomously record the signals from up to 4 fibres, store this data on-board in non-volatile memory and transmit the data back to a base station computer (or download to a local PC / laptop). 32MB of on-board memory is available which is sufficient to store approximately 600 separate DTS measurements. The raw data is processed (and temperature calculations are performed) on the base station or laptop and this is where the data is permanently stored. The base station server runs Sensornet software which communicates with multiple Oryx units in the field and allows configuration changes from a central control room (CCR). Users can connect to the base station to view the temperature data using Sensornet software

© Sensornet 2007

or other third party tools. The data files can also be imported into a spreadsheet application.

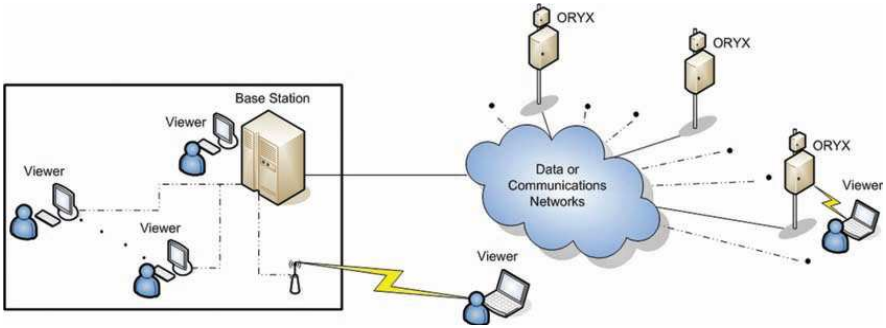


Figure 2 - Overview of communications & connectivity

The Oryx is provided with dedicated software to communicate with and configure the remote DTS unit(s) – Oryx data collection (ODC) software. It is important to note that since the temperature calculation is performed on the base station server, third party communication to the Oryx its self is not required and only occurs through the Sensornet ODC software. Because of the sophisticated nature of the Oryx and the volume of data collected and transmitted back to the base station, a proprietary protocol has been established for direct communication with the Oryx. This currently operates over a serial RS232 communications link. Sensornet provides several options for this communications link, such as radio or GPRS modems, serial-over-Ethernet or alternatively, existing communications infrastructure can be used if the link is transparent to the protocol used. If a communications link is not available, the ORYX unit will buffer measurement data on board until a link is established or drive-by data collection is undertaken.

Other features of the Oryx are:

- On-board real-time clock (battery backed)
- Two independent PT100 resistance probes for aiding calibration
- Robust, fault tolerant communications (data is stored on-board until download acknowledged)
- Power saving feature – idle mode activated if no measurements scheduled for >1min
- Low power operation – Solar or Wind power can be used

© Sensornet 2007

- Self-protecting features – idle mode activated if environmental temperature out of range or power supply voltage outside limits

© Sensornet 2007

OPTICAL AND ELECTRICAL CONNECTIONS

The following diagram illustrates the connections to the Oryx DTS unit. All electrical connections are by removable screw terminals and optical connectors are E2000 APC type.

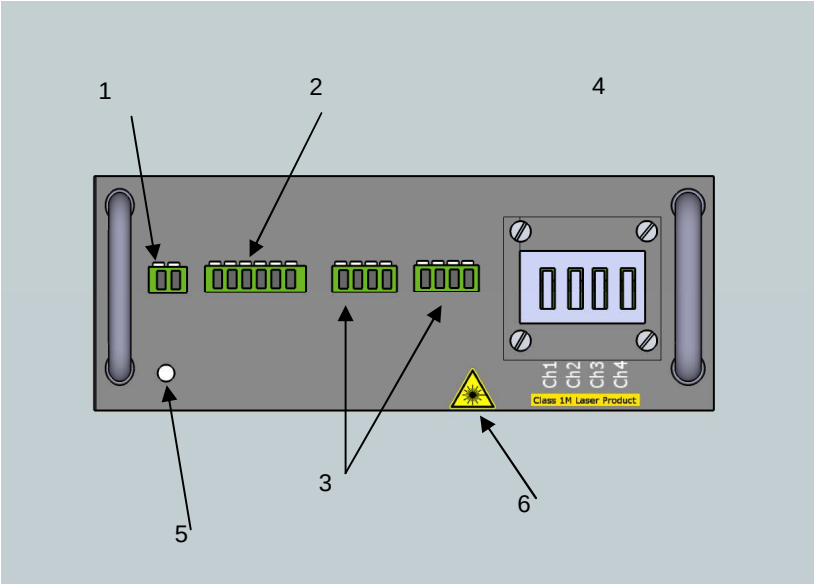


Figure 3 - Oryx Connector Panel

LIST OF CONNECTIONS:

1. Input power
2. Serial RS232 communications ports, Com1 & Com2
3. PT100 external probe connections
4. Fibre Optic connector panel
5. Earthing point
6. Laser emission warning symbol

© Sensornet 2007

The table below lists all of the electrical connections.

TABLE OF CONNECTIONS

Label	Connection	Note
0V	Negative terminal of supply	
+V	Positive terminal of supply	
GND	Ground	
Rx	Com Receive	Connect to Tx terminal on PC / modem com port
Tx	Com Transmit	Connect to Rx terminal on PC / modem com port
I1+	Current source	These terminals are for a standard 4 wire connection to a platinum resistance thermometer
V1+	Sensing terminal	
V1-	Sensing terminal	
I1-	Current sink	

Each of the electrical connector terminal blocks can be removed for ease of wiring. It is recommended that the Oryx unit be earthed, especially in out-door installations.

Optical connections are made by simply inserting the E2000 connector into the appropriate optical channel. Press the latch & pull to disconnect (see Figure 4).

© Sensornet 2007

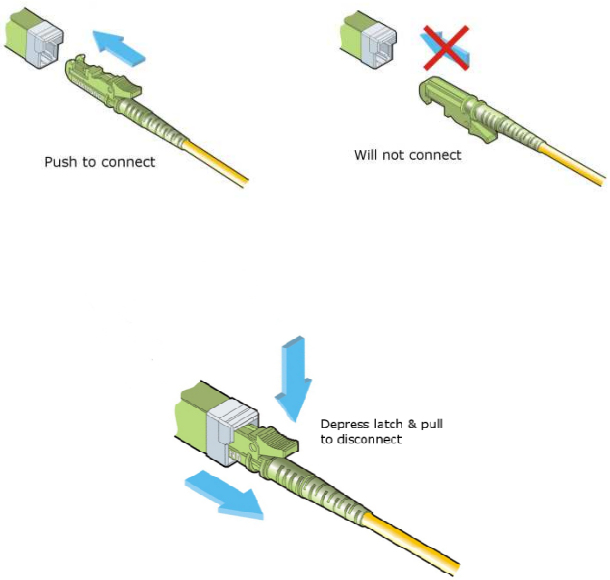


Figure 4 - Connecting and disconnecting the E2000 optical connector

NOTE: Ensure the optical connector is pushed firmly into the housing and latches to obtain proper mating

Typical connector loss is 0.1 – 0.3dB. Values above 0.4dB would warrant cleaning the connectors. The fibre optic connector panel can be removed by unscrewing the four knurled thumb screws and carefully removing the panel. There is sufficient slack on the inside fibre pigtails to allow removal and cleaning.

CAUTION! If one of the internal optical connectors is damaged, the unit will need repair at Sensornet. Only remove the Optical Connector Panel if a dirty connector has been inserted or the optical connector loss cannot be reduced by cleaning the external connector.

In cases where the DTS is connected and disconnected frequently (e.g. if the Oryx is transported to different sites for measurements), the use of an external 'sacrificial'

© Sensornet 2007

patch lead is recommended. This will add a small amount of additional loss but if the patch-lead is damaged, it can easily be replaced.

NOTE: Please ensure the optical connectors are clean before inserting into the Oryx. Dirty optical connectors are a major source of signal loss. Clean the optical connector with a suitable cleaning cassette or alcohol-damped swab. It may be necessary to remove the Fibre Optic Connector Panel and clean the connector *inside* the Oryx if a dirty connector has been inserted

Specialist connector inspection microscopes are useful for verifying that connectors are clean and free of foreign material. Video inspection scopes can also be used to view the condition of connectors. There are two methods for cleaning connectors and couplings which are approved by Sensornet Ltd. The technique used is dependent on the type of contamination. If the connector has been exposed to slight dust contamination, the preferred method is using a 'cassette style' cleaning tape. If the connector has been exposed to grease, lint free tissues wetted with alcohol or pre-soaked wet wipes should be used.

WARNING! UNDER NO CIRCUMSTANCES SHOULD CONNECTIONS BE INSPECTED WHILE THE DTS SYSTEM IS LIVE AND OPERATING.

© Sensornet 2007

COMMUNICATIONS OPTIONS

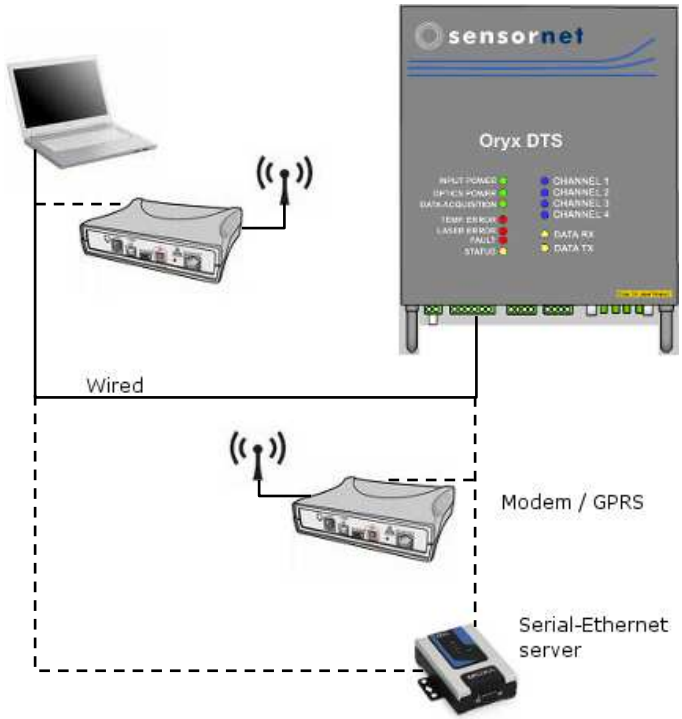


Figure 5 - Communication options

By default, the Oryx DTS ships with both com ports configured for direct serial (RS232) connection. This mode is used in the following situations:

- Direct connection of PC or laptop to serial port
- Connection of Oryx to an Ethernet-to-serial device server
- Connection to a Radio or GPRS data modem

These communications links typically provide “always up” connection and are transparent to the protocol used.

© Sensornet 2007

The Oryx DTS also supports modem commands (AT command set) for analogue communications links and this mode is used in the following situations:

- A telephone line is used with an analogue modem
- GSM modem using the GSM network

The Oryx should have one of the com ports configured for modem operation by setting the baud rate, initialization string and dial out telephone number. At the base-station, a corresponding modem should be installed and configured using the ODC software, with the matching baud rate and the Oryx telephone number.

If a radio or GPRS modem-router is installed, these should be configured as per the manufacturer instructions at the remote Oryx site and, if applicable, the base-station.

NOTE: For GPRS, the user will be required to provide a SIM card with fixed IP address suitable for machine-machine communications. Your network provider should be able to help with the configuration & VPN (virtual private network) settings.

If using a serial-Ethernet converter, only one device needs to be installed at the Oryx site but software device drivers will need to be installed on the PC / laptop to map a TCP socket to a virtual com port.

© Sensornet 2007

FRONT PANEL INDICATORS

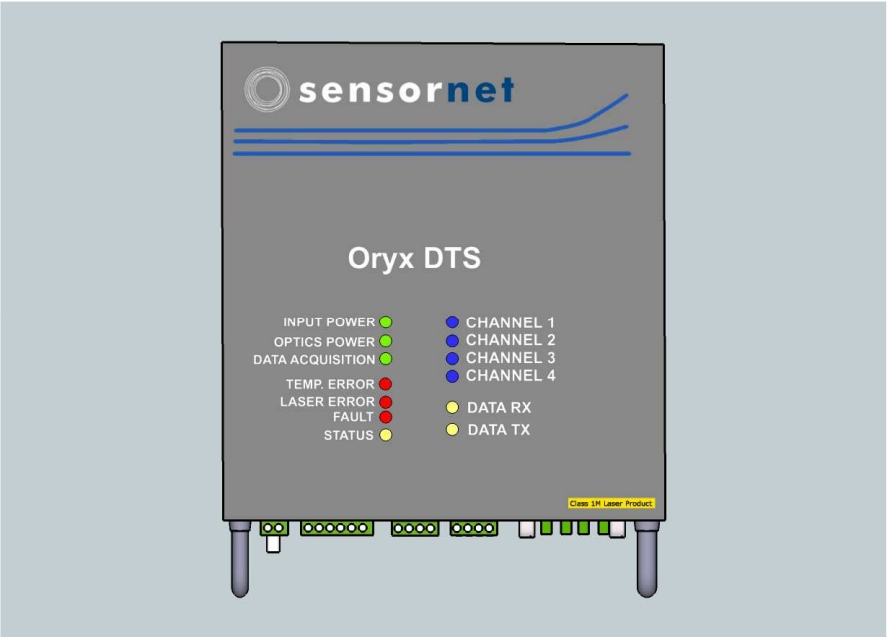


Figure 6 - Oryx Front Panel – description of labels below.

INPUT POWER

When illuminated, this indicates that power is applied and the DTS is in operation.

OPTICS POWER

When illuminated, this indicates that power is applied to the optics & laser unit. During an idle period, this LED is not illuminated and no power is applied to the optics and laser.

DATA ACQUISITION

When illuminated, this indicates that power is applied to the data acquisition board. During an idle period, this LED is not illuminated and no power is applied to the board.

© Sensornet 2007

CHANNEL INDICATORS

These lights indicate which fibre channel is active. When lit, the relevant fibre is being measured. If no lights are illuminated, the system is in idle or warm-up mode.

TEMP. ERROR

When illuminated, indicates that the DTS is outside its environmental operating temperature range. No measurements will occur whilst this condition is present. Once the temperature is back within range, the error will clear and the next scheduled measurement will take place.

LASER ERROR

When illuminated, indicates that the laser is outside its operating temperature range or a low laser output power. No measurements will take place while this condition is present. Once the temperature is back within range, the error will clear and the next scheduled measurement will take place.

FAULT

When illuminated, indicates a general system fault not specifically identified by the other panel indicators.

STATUS

This LED will flash during normal operation of the Oryx DTS. In general the flash rate is as follows:

System idle:	slow flash
Active measurement in progress:	fast flash

If this LED does not flash on / off or is constantly illuminated, the system is in an error condition. However, note that during data transfer or heavy communications activity, this LED may not flash.

DATA TX / DATA RX

These LEDs flash on & off indicating communications activity.

© Sensornet 2007

INSTALLATION GUIDELINES

PHYSICAL INSTALLATION

The Oryx DTS is designed for internal or external use but should be mounted within a suitable enclosure to protect against direct exposure to the elements. A sealed enclosure (to IP55 or better) is recommended in extremely sandy / dusty environments or offshore sea-based locations. Mounting brackets are provided and dimensions are detailed in section 0, page 93.

CAUTION! Extreme care should be taken when connecting or disconnecting the optical connectors. Please ensure no particles or liquid enters the optical uniters and that the cable connector ferrules are clean before insertion.

OPERATION IN HOT CLIMATES

Note that the maximum operating temperature of the Oryx DTS is 65℃ and care should be taken when mounting the Oryx in an enclosure. If the Oryx is housed inside a sealed IP55 enclosure or similar, please ensure sufficient free air flow around the housing. A sun screen / shadow box is essential to prevent heating by direct solar gain.

POWER SUPPLY

The Oryx DTS operates on nominal 12 to 24VDC with a power consumption of 18W maximum. (The power supply used should be able to provide an initial turn-on surge current-refer to electrical specifications on page 92). In standby mode, where no measurements are being taken, the power consumption is 0.5W. In remote regions, a suitable battery backed power source should be provided considering the measurement duty cycle. Sensornet can provide power solutions based on solar or wind turbine systems, please contact us for further information if a power source is required.

Once the electrical and optical connections have been made, the Oryx DTS is ready to use. Before operating the Oryx DTS, ensure all users have read and fully understood the safety section of this user manual.

SOFTWARE INSTALLATION

The Oryx software should be installed on the base-station server or laptop PC to allow setup of the Oryx DTS and collection of the data. The Oryx software is

© Sensornet 2007

composed of two packages, the Oryx Data Collector (ODC) and the Oryx Data Viewer (ODV).
No software is required to be installed on the Oryx unit itself, this comes ready programmed.

NOTE: If Sensornet have supplied the computer hardware, this will have the ODC and ODV pre-installed and configured.

The software is installed by simply inserting the CD into the computer. The installer should automatically launch, however if it does not, simply browse to your CD drive and double-click the setup.exe in the root folder.

NOTE: If the software is being upgraded, the old software should be uninstalled before attempting to install the new version.

© Sensornet 2007

GETTING STARTED

The Oryx DTS is controlled and configured using the Sensornet Oryx Data Collector (ODC) software application. This software also downloads data from the Oryx and generates the temperature data files on the base station server or laptop PC. Temperature data is viewed by means of the Sensornet Oryx Data Viewer (ODV) application which reads the generated data files. A spreadsheet application can also be used to view the temperature data files.

NOTE: The ODC software is included with the Oryx DTS. The ODV software is licensed on a per-computer basis (each instance on a different PC requires a new license). One license is provided with each Oryx unit and further licenses can be purchased from Sensornet.

The Oryx DTS ships with a “default_idle” configuration such that all channels are deactivated - the laser will not power on and no measurements will be taken. (Setting all channels to inactive is one way to put the Oryx into permanent idle mode). Apply a suitable power source (12 – 24VDC) and connect the supplied serial cable to the PC and either of the Oryx com ports. Once the Sensornet software is installed on the PC follow the instructions in section 0 to configure the PC & Oryx. This is already done if the unit ships with a server or laptop from Sensornet.

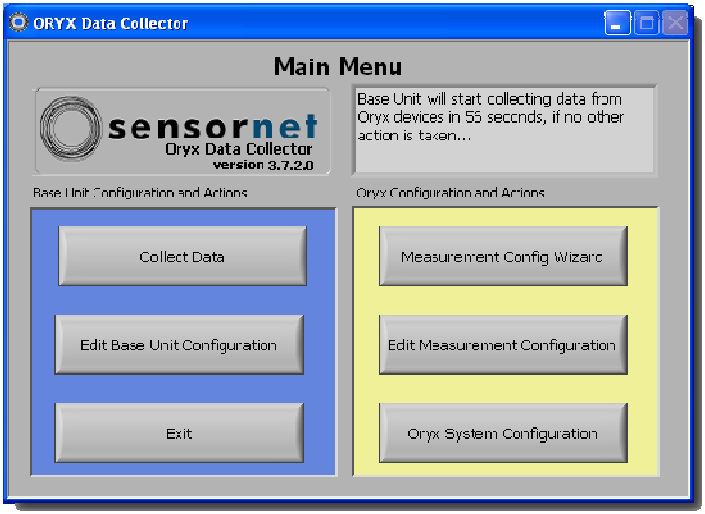


Figure 7- The ODC main menu

© Sensornet 2007

The “Edit Measurement Configuration” button enables the user to set an active configuration. The default_idle configuration can be modified to start taking measurements although the user is recommended to enter a new installation name. Enable channels using the “Channel specific settings” tab and the “Channel details” sub-tab. Measurement or signal averaging time can be set, as well as the overall repetition time under the appropriate tabs. For example, setting 2 channels active, measuring each channel for 5 minutes, repetition time 1 hour, would result in 5 minutes measurement for each channel repeated every hour. Select the “Measurement Config Wizard” button to be guided through the measurement setup process of the DTS.

NOTE: If the idle time is greater than 60 seconds, the laser and data acquisition module will be powered down between measurements to reduce power consumption.

Please see section 0 for how to set up an Oryx with the ODC and a description of creating and editing configuration files and section 0 for a guide to the configuration wizard.

NOTE: Clicking “UPLOAD” will upload a new configuration to the Oryx and will DELETE ALL MEASURMENTS on-board the Oryx at that time. (Any data already downloaded to the PC is unaffected).

If selecting to start measurements as soon as possible, there may be a delay of up to one repetition time before commencement of the first measurement.

Once the Oryx has been set up with a measurement configuration, click the “Collect data” button to begin monitoring each Oryx connected to the base station PC. The ODC software will receive a “data_ready” signal from each Oryx when a measurement has been recorded and will automatically download all data from the DTS. The user can also query the status of each Oryx by clicking the “Get Status Update” button on the status panel (see Figure 25).

NOTE: Data will only be downloaded from the Oryx when the ODC is running and the “Process Log” or “Oryx Status Panel” screen is visible. If this software is not running or there is a communications failure, data will be stored on the Oryx until communication is restored.

NOTE: To avoid frequent communications traffic with the Oryx, the ODC software will wait for a “data_ready” message from the Oryx before downloading data. The user can force all data to be downloaded by simply clicking the relevant “Get Status Update” button on the Oryx status panel.

© Sensornet 2007

While the ODC is downloading data from the Oryx device(s) connected, live temperature data can be viewed using the ODV software. Please see the ODV section later in this manual (Page 74).

© Sensornet 2007

THE ORYX DATA COLLECTOR (ODC)

This section describes the use of the ODC software for communicating with & setting up the Oryx DTS. Please note that some details of the software may vary if your system is running a different version.

Once the data collector software has been installed from the CD-ROM, the ODC can be configured to auto-start if installed on a permanent base station server. This would ensure data is downloaded even if the computer rebooted for some reason. On a laptop or other PC, the user can launch the ODC as required to configure or collect data from Oryx unit(s).

NOTE: If Sensornet have supplied the computer hardware, this will have the ODC and ODV pre-installed and configured for the Oryx unit supplied.

NOTE: Any reference to “base station” server, equally applies to a laptop or other PC with the installed software.

SELECTING ROOT & ADDING AN ORYX

If it is the first time the ODC is run, the user will need to specify a directory as the ROOT path and the dialog box shown in Figure 8 will be presented. All data and configuration files will be stored below this directory.

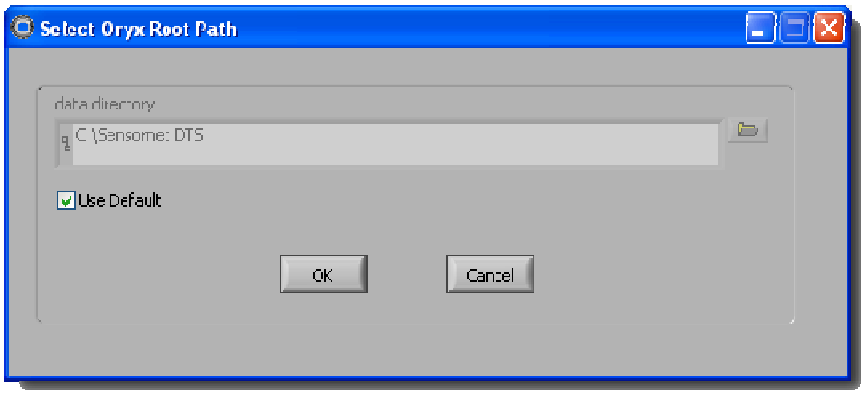


Figure 8 - Select Root Path

© Sensornet 2007

It is recommended that the user uses the default ROOT folder which is “c:\Sensornet DTS”. To use a different folder instead, first uncheck the “use default” checkbox. Now clicking on the folder icon, allows the user to browse for a different folder. Once the browse window has the desired folder open (i.e. the folder you wish to use as root is open and displayed in the “look in” field) click the button “Current Folder” (see Figure 9).

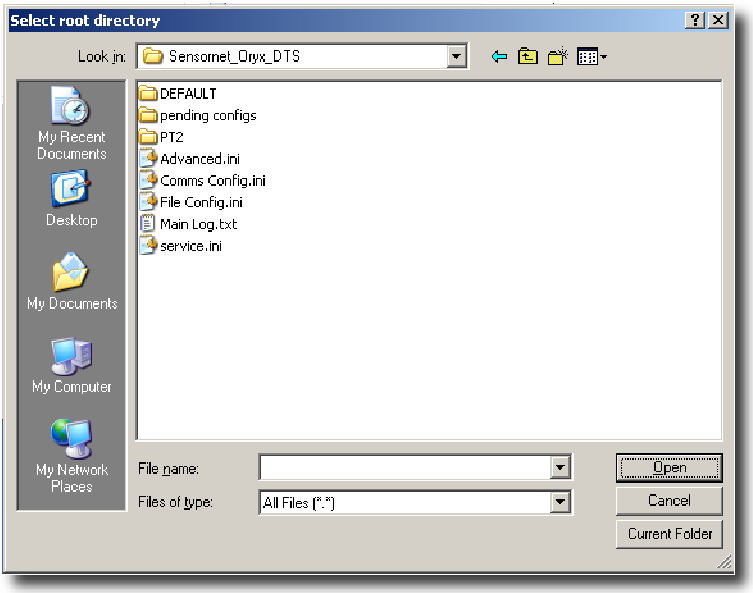


Figure 9 - Example of root directory - click ‘Current Folder’ to select ‘Sensornet_Oryx_DTS’ as the root

Once the software has initialised, the Sensornet DTS Oryx Main Menu will appear as shown in Figure 10. At this point, the only options available will be “Edit Base Unit Configuration” and “Exit”.

© Sensornet 2007

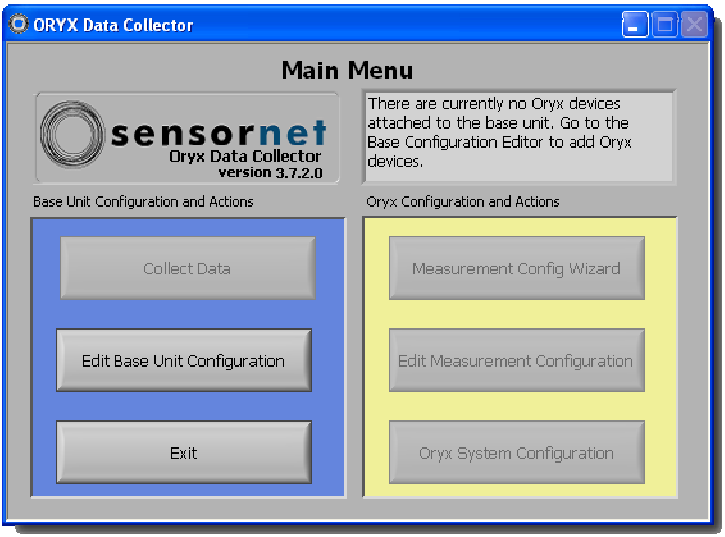

ORYX Data Collector
Main Menu
sensornet
Oryx Data Collector
version 3.7.2.0
There are currently no Oryx devices attached to the base unit. Go to the Base Configuration Editor to add Oryx devices.
Base Unit Configuration and Actions
Oryx Configuration and Actions
Collect Data
Edit Base Unit Configuration
Exit
Measurement Config Wizard
Edit Measurement Configuration
Oryx System Configuration

Figure 10 - ODC Main Menu with no Oryx devices added

EDIT BASE UNIT CONFIGURATION

Select 'Edit Base Unit Configuration' to make the Base Unit aware of any Oryx devices and how to communicate to them. This will display the dialog window shown in Figure 11.

© Sensornet 2007

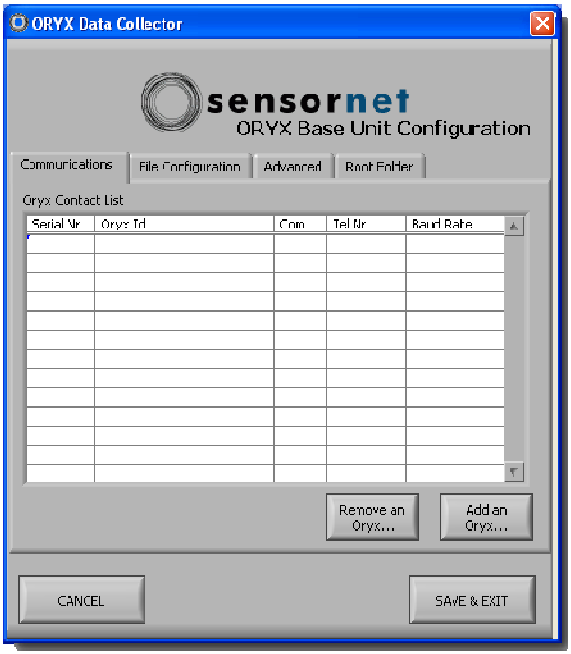


Figure 11 - Base unit configuration screen

To add an Oryx to the base station click “Add an Oryx...” on the communications tab. Once an Oryx has been added to the base station the user is able to configure and download measurements from the Oryx. To remove an Oryx click “Remove an Oryx...” and select the Oryx to be removed. This will not delete any data or configuration files that have been stored for that Oryx.

NOTE: Only one Oryx can be connected (or associated to), any particular COM port at any one time.

On clicking “Add an Oryx...”, the following dialog will be presented (Figure 12):

© Sensornet 2007

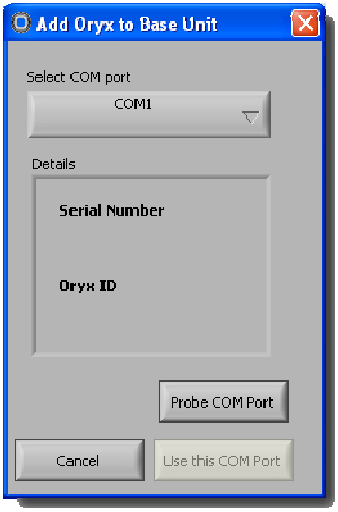


Figure 12 - Associating an Oryx with a COM port

Select the COM port that the Oryx is connected to from the drop-down menu at the top (if a COM port is not listed, please see the trouble shooting section at the end of this manual). If communicating to the Oryx via a modem, select the COM port to which the modem is connected. Clicking on 'Probe COM Port' will enable the software to search for and connect to the Oryx on the selected COM port.

The ODC will scan the com port selected and automatically determine if an Oryx is connected directly or via a modem unit. All possible baud rates will be scanned, so this process can take several minutes. If there is a modem connected to the COM port, the user is prompted for a telephone number to dial & connect to the remote Oryx device. The base station telephone number is also prompted for so that the Oryx can dial-in.

Once an Oryx has been added, select the "File Configuration" tab (Figure 13). Here you can select what output (file types saved) should be produced from the Oryx. As a guide minimum, the following files types should be saved:

- *.ddf data (distributed temperature data files)
- *.tdf (temperature information about zones)
- *.tcd data (PT100 and internal reference measurements)

(The *.raw data files are very useful if a problem needs to be diagnosed by Sensornet)
For further information, see page 44 for a description of the file types.

© Sensornet 2007

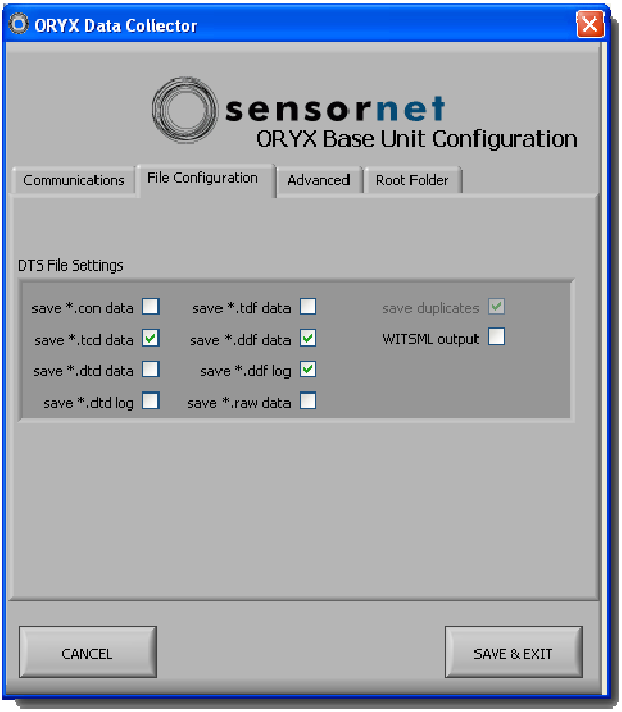


Figure 13 - File saving settings

The settings from the “Advanced” tab are used to set the frequency of communications and will become more important once additional Oryx devices have been added to your base unit. Figure 14 shows the options available and they are described below.

“COMMUNICATE WITH EACH ORYX AT LEAST ONCE EVERY…”

The Base Unit will attempt to make a connection to the Oryx when it has not had any connection with that device for the time period specified here. This ensures that even if an Oryx does not report back to the base station, the base station will attempt communication with that Oryx and obtain its system status. This will alert the user of possible problems with either communications or the device.

© Sensornet 2007

"ORYX CONNECTION SESSION LENGTH"

The Base Unit will disconnect from an Oryx it is connected to after the time period specified. This will give the Base Unit a chance to connect to other Oryx devices attached to the Base Unit. This ensures that a particular Oryx does not occupy the Base Unit at the cost of ignoring the others for long periods of time.

"BREAK UP MEASUREMENT DATA IN PACKETS"

If you enable this option all the measurement data will be broken up into smaller packets. You can also set the size of the data packets. This could be useful for certain installations where you have a less reliable communications link between the Oryx and the Base Unit. If the transmission of a smaller packet fails then only that packet has to be retransmitted instead of the complete data file.

"IGNORE DATA READY MESSAGES FROM ORYX"

This will cause the Base Unit to ignore "data ready" messages from the Oryx. When this option is not enabled an Oryx will let the Base Unit know as soon as it has acquired some data. In certain circumstances it might be more beneficial for the Base Unit to rather poll the Oryx for data at regular intervals.

© Sensornet 2007

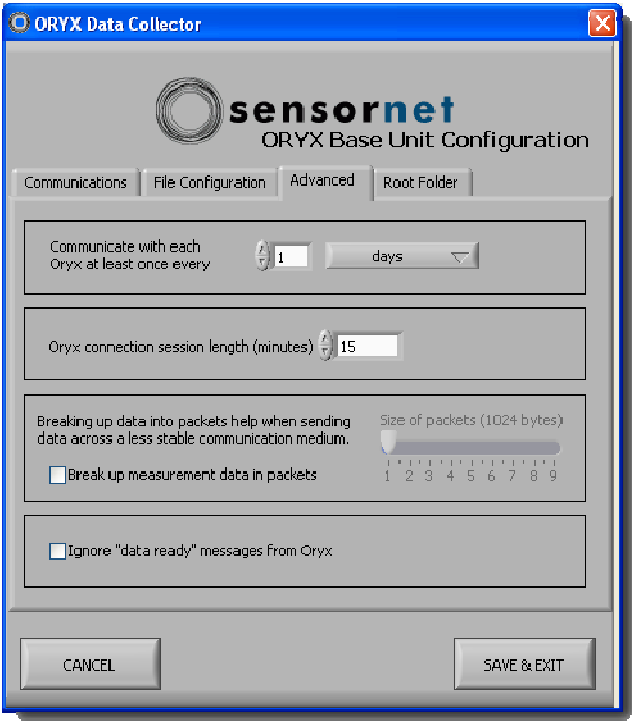


Figure 14 - Base Unit Configuration – Advanced tab

The settings from the “Root Folder” tab (see Figure 15) allows you to change the current ROOT folder of the Oryx Data Collector. Use the browse button to select a new folder to be used as ROOT. There are two options available when moving the ROOT folder:

- Create new Root Folder only
- Create new Root Folder and move historic data

They are both described below.

Create new Root Folder only

This option will move all the necessary configuration files from the current ROOT folder to the new folder, but none of the acquired historic measurement data. This

© Sensornet 2007

will allow you to carry on communicating to all currently “attached” Oryx devices without having to “reattach” them.

Create new Root Folder and move historic data

This option will move all the necessary configuration files from the current ROOT folder to the new folder as well as all the historic measurement data.

Click the Move to new Root Folder button to affect the change.

NOTE: When you have changed the Root folder for the ODC and you have already set the Root folder for the ODV (see “The oryx data viewer” on page 74), you will have to change the Root folder for the ODV as well. To do this delete the “C:\Program Files\Sensornet Oryx\ OryxDataViewer.ini” file. It will then prompt you to set the Root folder again when you launch the ODV application.

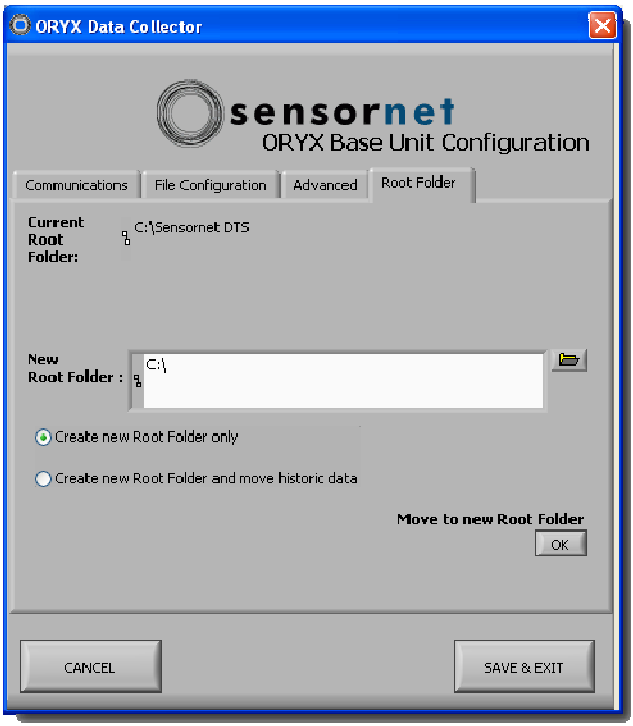


Figure 15 - Base unit Configuration - Root folder

© Sensornet 2007

Select “Save & Exit” to store the settings and return to the main menu.

CONFIGURING THE ORYX

The main menu is grouped into two sections, on the left (background colour blue) are the actions relating to configuring the base-station server or laptop and on the right (background colour yellow), are those actions relating to setting up and controlling the remote Oryx unit itself. The “Edit Base Unit Configuration” button is described in the previous section.

The Oryx unit ships from the factory with default settings which the user will most likely need to change. The sections below describe how to set parameters on the Oryx (e.g. date & time) and set up the DTS measurement.

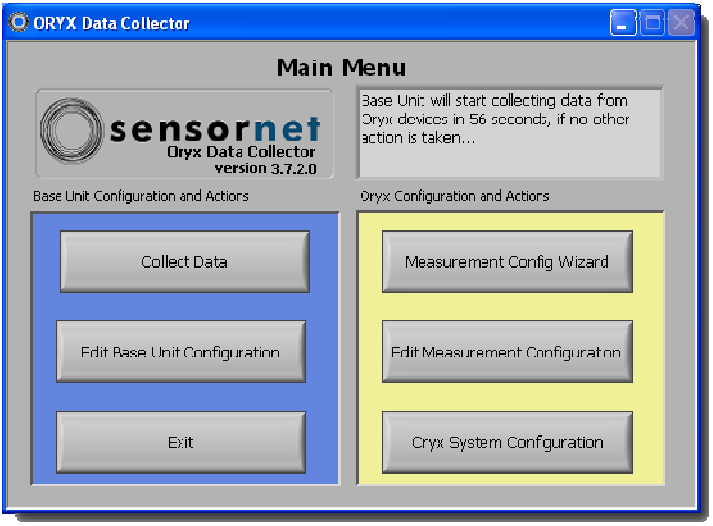


Figure 16 - ODC Main Menu

© Sensornet 2007

ORYX SYSTEM CONFIGURATION

This option enables the date & time stored on the Oryx to be updated as well as the communications parameters to be modified.

If more than one Oryx has been set up on the base unit, select the appropriate Oryx from the drop down menu at the top of Figure 17.

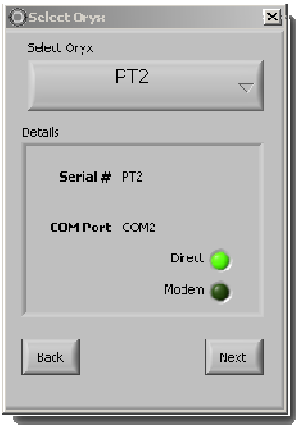


Figure 17 - Selecting an Oryx to configure

The serial number and base station PC COM port used are displayed. Click “Next” and the dialog in Figure 18 will be displayed.

© Sensornet 2007

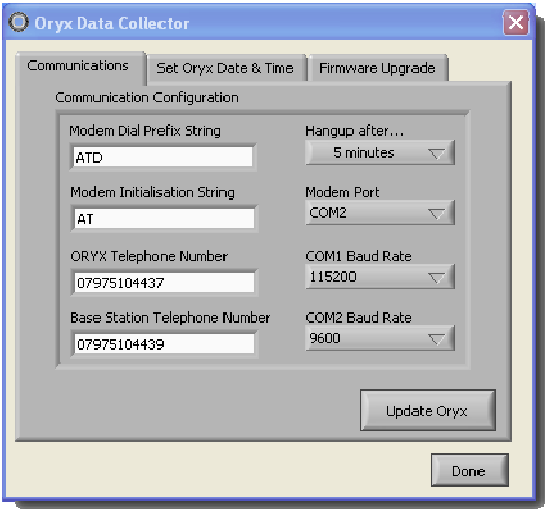


Figure 18 - Setting Oryx communication parameters

NOTE: The COM1 & COM2 labels referred to in Figure 18 are the communications ports on the Oryx unit, not the base PC.

By default, both the communications ports on the Oryx are configured for direct connection, not modem use. A description of the settings and options are listed below.

- *Modem dial & initialization string* – Dialling and initialization strings for the attached modem. The default values are universally accepted but please check the particular modem being used
- *Oryx & Base station telephone number* – If a modem is to be connected, enter the appropriate telephone numbers here
- *Hang up after…* - Oryx will hang up the modem after this time out with no comms activity
- *Modem port* – Displays or selects which COM port on the Oryx is connected to a modem

© Sensornet 2007

- *COM1&2 baud rate* – Displays or selects the baud rate for each COM port. The baud rate may need to be reduced if excessive communication errors are reported

- *Update Oryx* – Sends the displayed parameters to the Oryx unit. Any new values will be applied immediately

CAUTION! If the baud rate or modem port is changed and the values are up loaded to the Oryx, communication will be temporarily lost. Re-establish connection by removing the Oryx and scanning for it again (page 22)

It is recommended that COM1 on the Oryx is reserved for direct communications and COM2 for modem communications.

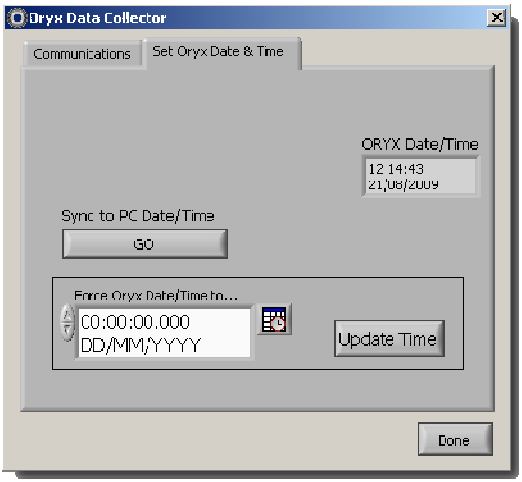


Figure 19 - setting Oryx date & time

The Set Oryx Date & Time tab allows the user to synchronise the Oryx on-board time with the PC being used or set the date & time to a particular value (e.g. to take account of day light savings or if the Oryx is in a different time zone to the user).

NOTE: If the base PC or laptop date and time are changed, ensure that the PC is re-booted before attempting to synchronise the Oryx time. If this is not done, the Oryx may be updated with the old PC date & time.

© Sensornet 2007

Clicking the button labelled “GO” will synchronise the Oryx date & time to that of the computer being used.

When all the Oryx settings have been completed, click on the “Done” button which will return the screen to the ODC main menu.

EDIT MEASUREMENT CONFIGURATION

Selecting this option allows the user to directly modify the measurement settings of an Oryx. Use this option once you are familiar with the parameters or simply need to change the measurement time or range. Configurations that have been previously set for the particular Oryx connected, or other Oryx device, can also be recalled for use or edited.

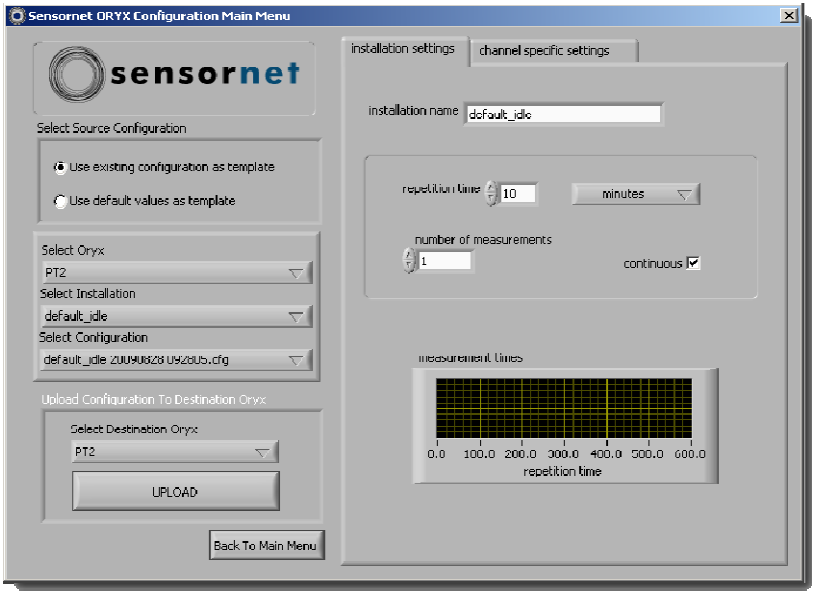


Figure 20 - Configuration Editor Main Menu

In most cases, select “Use existing configuration as template” for the source configuration and this will allow the user to select an Oryx device, a particular configuration or ‘installation’ name and a particular configuration file associated with that installation name.

© Sensornet 2007

NOTE: Different configuration files may be associated with a given installation name. This gives the user the option to modify the measurement parameters without changing the installation name.

The configuration name is composed of the installation name, followed by a date code and time stamp with a file extension of *.cfg. If measurement parameters have been changed without changing the installation name, a unique cfg file will still be created and a list of all such files will be seen under the “Select Configuration” drop down button.

If the “Use default values as template” option is checked, the channel specific settings will be populated by default values.

The “Installation Settings” tab allows the user to enter a name for the configuration as well as set the repetition time (time period between measurements) and whether the Oryx should measure continuously or only perform a set number of measurements.

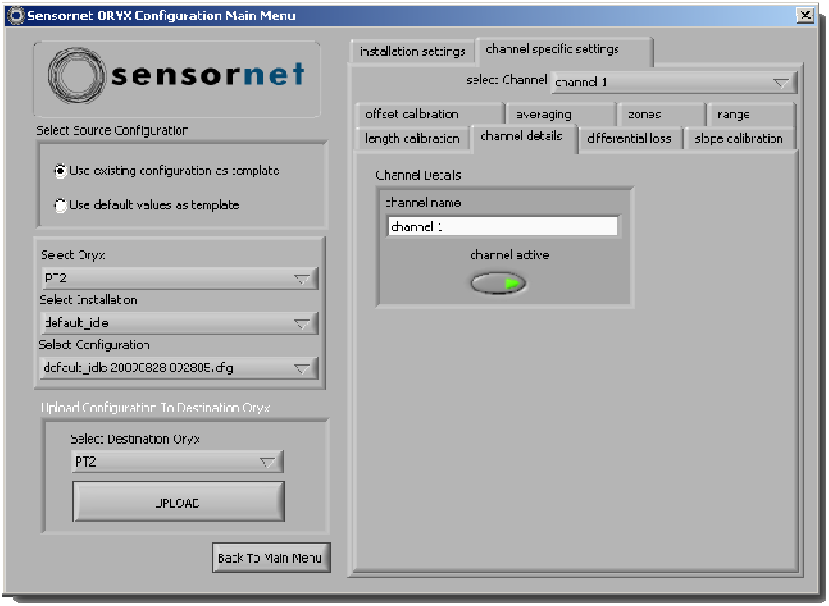


Figure 21 - Editing the Channel settings

© Sensornet 2007

The “Channel specific settings” tab is where the detailed measurement settings are entered. A particular channel of the Oryx (channel 1 to 4) is selected from the drop down menu near the top of the window (Figure 21). A channel is made active by selecting the ‘channel details’ sub-tab and clicking the ‘channel active’ button to make it illuminated. The other sub-tabs set various calibration parameters and the range and averaging time.

NOTE: See the section on “Oryx configuration wizard” page 52, for a more detailed explanation of the terms and parameters that can be set under the “Channel specific settings” tab.

NOTE: Some values, specifically distance values, will be coerced to the nearest allowable value to that entered by the user. Hence these parameters will not be set exactly as entered.

Once one or more channels have been activated for measurement, the “installation settings” tab shows a coloured representation of the measurement settings for easy review. As can be seen in Figure 22, two channels are active each with a measurement or averaging time of 1 minute and a repetition time of 5 minutes. If the idle period is greater than 1 minute, the laser and data acquisition module are powered off to reduce power consumption.

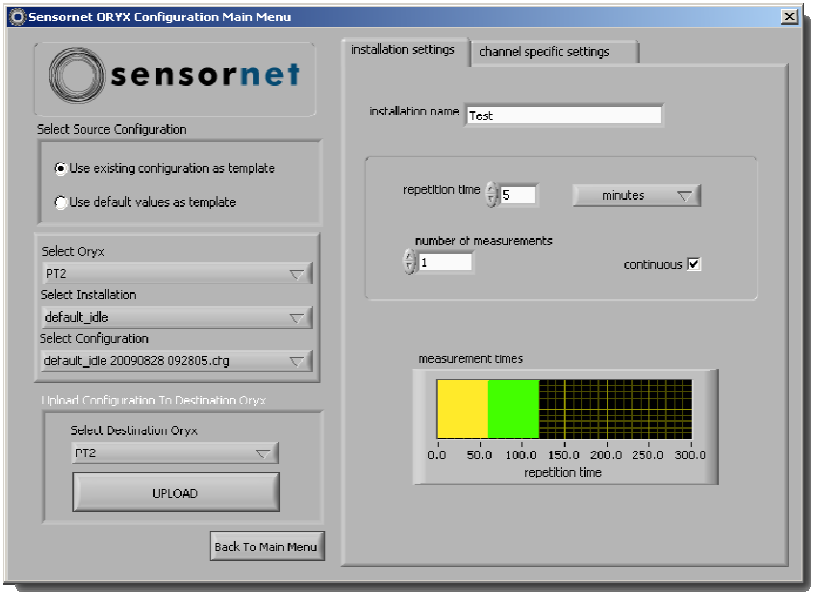


Figure 22 - Edit configuration – 2 channels active

© Sensornet 2007

Once all measurement parameters have been set, the user is ready to upload the configuration to an Oryx. Select the Oryx required and click “Upload”. The user is prompted to correct any errors in the configuration and warnings (such as Channel X not activated) are displayed. Errors will need to be corrected by clicking “Edit values” while warnings are for information only.

NOTE: Clicking “UPLOAD” will upload a new configuration to the Oryx and will DELETE ALL MEASURMENTS on-board the Oryx at that time. (Any data already downloaded to the PC is unaffected).

The user is prompted to select the start time of the measurement cycle (see Figure 23).

NOTE: Ensure the Oryx date-time has been synchronised to the base station. Date & time entered should be Oryx time.

NOTE: If selecting to start measurements as soon as possible, there may be a delay of up to one repetition time before commencement of the first measurement.

Figure 23 - Selecting the start time of measurement cycle

MEASUREMENT CONFIG WIZARD

The “Measurement config wizard” option allows the user to be guided step-by-step through the DTS setup, ensuring the calibration parameters are optimised for the

© Sensornet 2007

fibre cable attached to each channel. The user is initially prompted to select an Oryx and is then presented with the first screen of the configuration wizard.

The details of the configuration wizard and DTS measurements with the Oryx are described in detail under “Oryx configuration wizard”, page 52.

COLLECT DATA

Collect Data enables the base station to communicate with an Oryx and download data. This option will automatically be selected after a 60s countdown that gives the user a chance to select one of the other options to re-configure the remote DTS or base unit.

NOTE: The automatic data collect feature is useful in a permanent unattended installation where data should be collected continuously. The ODC can be configured to restart if an operating system error or a reboot occurs.

Once Collect Data has been selected from the main menu a window is shown from where the user can switch between two views by selecting either ‘Process Log’ or ‘Oryx Status Panel’. The Process Log (Figure 24) allows the user to view a summary or detailed log of all processes occurring with the Oryx unit.

© Sensornet 2007

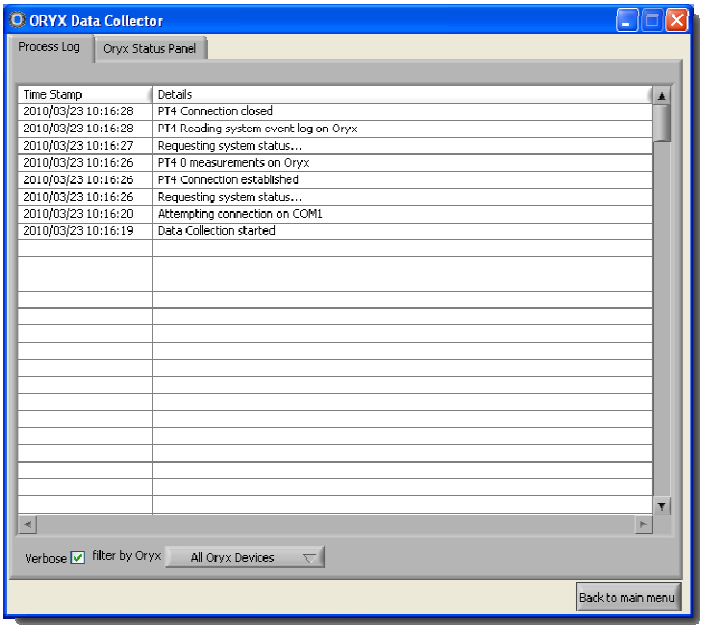


Figure 24 - ODC Process Log

Displayed logs can be filtered on a per-Oryx basis via the drop-down selection panel at the bottom of the window and un-checking the 'verbose' option will only display any error logs that have occurred.

The Status Panel (Figure 25) allows the user to get a status overview of an Oryx at a particular point in time. If more than one Oryx is connected to the base station, they will each have their own information fields and "Get Status Update" buttons in the status panel.

© Sensornet 2007

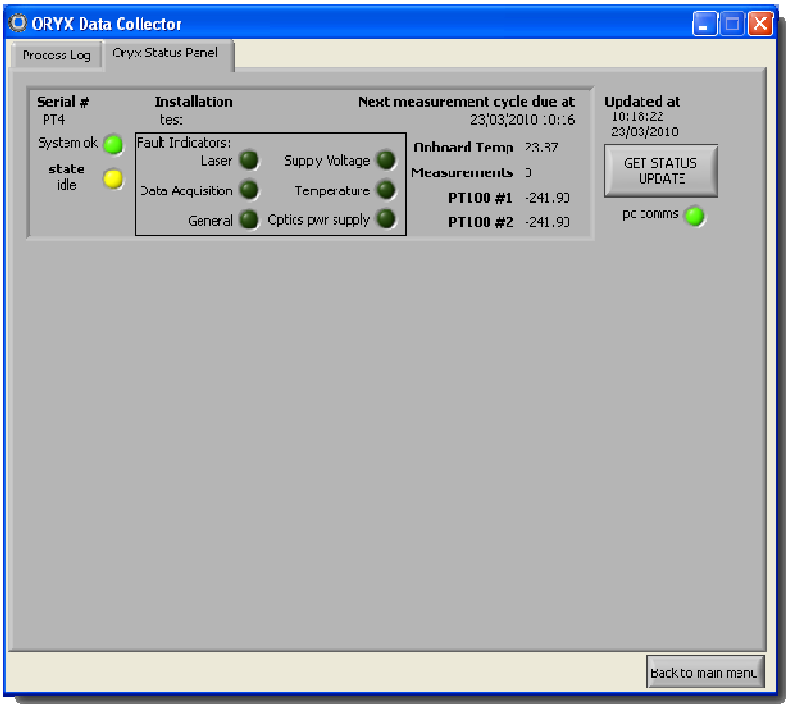


Figure 25 - Oryx Status Panel

A description of each of the information fields is given in the table below.

Label	Description	Note
Updated at	Time stamp at last status update	All errors and reported values are valid at this time only
PC comms	Red indicates a failure to communicate with Oryx	Comms failure or total power loss to Oryx

© Sensornet 2007

Installation	The name of the current configuration file	User set
Serial #	Oryx serial number	Factory set
Next measurement cycle due at	The time the next measurement cycle will start	
System ok	Green if system healthy Red on error	Errors will self-clear if the error condition clears.
State	This will be green when th Oryx is measuring and yellow when idle.	
Onboard Temp	Internal temperature of the Oryx	Unit will shutdown if outside of operating range
Measurements	Number of measurements stored on the Oryx	
PT100 #1&2	Value of the external PT100 probes	

If a system error has occurred, no measurements will take place and one of the following LED indicators will also be illuminated:

- *Laser error* – indicates a failure of the laser, either no output power or temperature control failed
- *Data acquisition error* – indicates an error with the data acquisition module.
- *Supply Voltage* – indicates that the power source to the Oryx is outside acceptable limits
- *Temp error* – indicates the Oryx device is currently outside its environmental operating temperature range
- *General* – Other system fault not specifically identified
- *Optics pwr Supply* – Indicates that there is a power supply issue to the Laser

If the ODC fails to communicate with the Oryx, the last reported status fields are greyed out.

© Sensornet 2007

THE DATA & LOG FILES

During operation, the ODC stores various data and configuration files within the Root folder specified at setup (see page 22). An example of the expanded directory route is shown in Figure 26. Directories are indicated by blue rectangles and files by yellow rectangles.

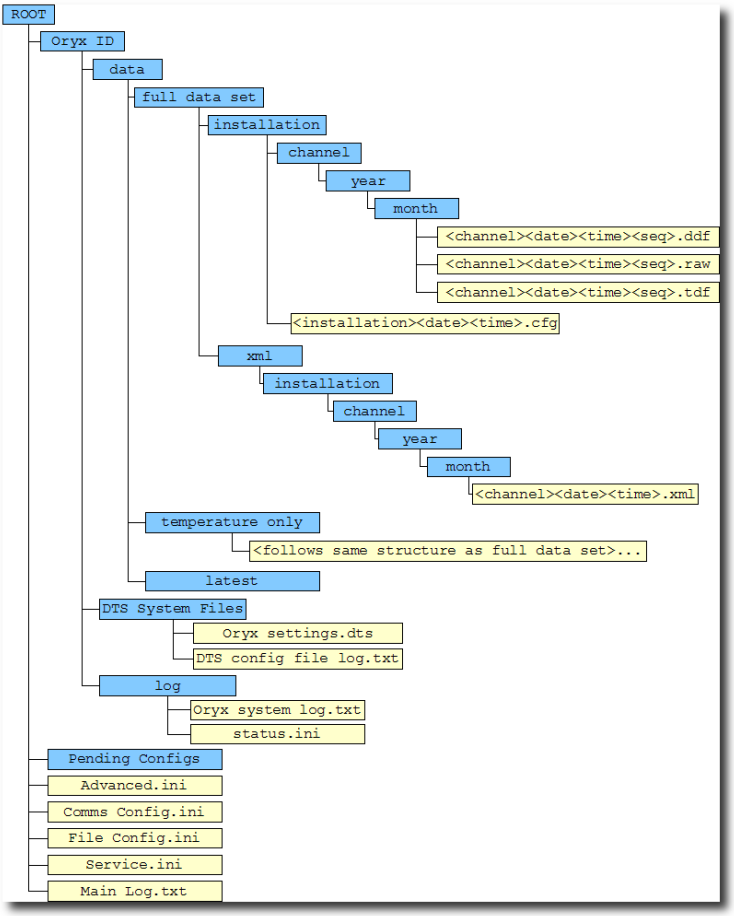


Figure 26 - Oryx DTS file structure

© Sensornet 2007

Under the 'Root' folder, there will be a folder for each Oryx that is connected, or has been connected, to the base unit. This 'Oryx ID' folder will have a name equal to the serial number of the DTS. All data, system and log files pertaining to a particular Oryx device are stored within this 'Oryx ID' folder.

ORYX DATA FILES

The Oryx DTS can generate different types of distributed data file that are stored permanently on the hard disks of the base station server or on a network share. These can be read using Sensornet ORYX Data Viewer (ODV) software or using other tools such as FloQuest software or simply imported into spreadsheet applications. The two types of text file are called Full Data and Temperature Only data files. The ODC software can also generate XML files (industry standard WITSML format), that can be imported into database applications.

A "latest" folder contains only the last (most recent) data for a specific ORYX, these files are overwritten with each new measurement. This fixed directory is useful for automatic downloading of the data files on a regular basis

The system generates historic data, with the files saved in a "Installation_name/Channel/Year/Month" hierarchy as shown in Figure 26.

Full Data Set files are the complete data set generated by the Oryx DTS system after every repetition of the measurement cycle. These contain the distributed temperature data, raw signal data and various installation details – name, time, date etc. These data files have a .ddf file extension.

NOTE: The date and time of the file as reported by the Windows OS, is simply the date and time the data was downloaded from the Oryx and may not correspond with when the log was taken.

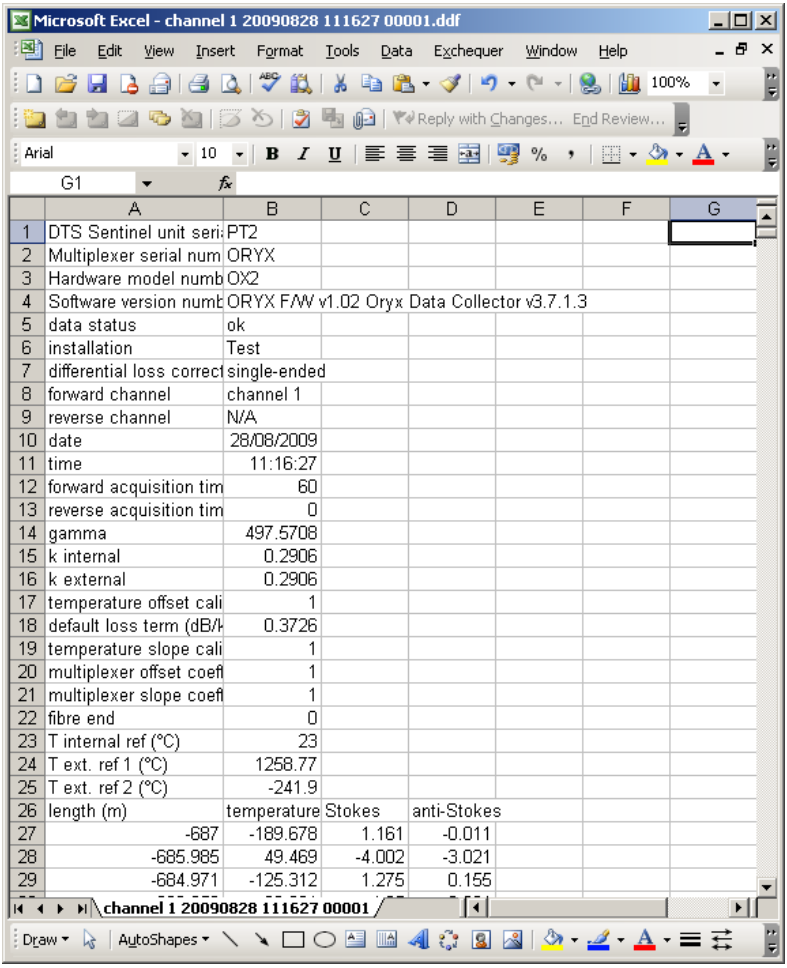
The *.dtd files stored under the temperature only directory contain a simplified header structure and only the temperature data in a single column with the first two numeric values being the start distance and the distance step size respectively. The values following are the temperature data recorded at each incremental distance step.

To import the data files into a spreadsheet, load the file via the 'all file types' extension. An example of the *.ddf file is shown in Figure 27.

It is worth noting that aside from the distributed temperature sensing data, the header section contains information such as the date and time of measurement, various measurement parameters, a data status field and some calibration constants used by the Oryx DTS. These constants are used in the optical performance calculations performed by the Sentinel DTS and may be required by Sensornet Ltd in case of a calibration error.

© Sensornet 2007

Other files types are described in the table on page 44.


Microsoft Excel - channel 1 20090828 111627 00001.ddf
File Edit View Insert Format Tools Data Exchequer Window Help
Arial 10
G1
channel 1 20090828 111627 00001
Draw AutoShapes

	A	B	C	D	E	F	G
1	DTS Sentinel unit seri:	PT2					
2	Multiplexer serial num	ORYX					
3	Hardware model numb	OX2					
4	Software version numb	ORYX F/W v1.02 Oryx Data Collector v3.7.1.3					
5	data status	ok					
6	installation	Test					
7	differential loss correct	single-ended					
8	forward channel	channel 1					
9	reverse channel	N/A					
10	date	28/08/2009					
11	time	11:16:27					
12	forward acquisition tim	60					
13	reverse acquisition tim	0					
14	gamma	497.5708					
15	k internal	0.2906					
16	k external	0.2906					
17	temperature offset cali	1					
18	default loss term (dB/k	0.3726					
19	temperature slope cali	1					
20	multiplexer offset coefl	1					
21	multiplexer slope coefl	1					
22	fibre end	0					
23	T internal ref (°C)	23					
24	T ext. ref 1 (°C)	1258.77					
25	T ext. ref 2 (°C)	-241.9					
26	length (m)	temperature	Stokes	anti-Stokes			
27	-687	-189.678	1.161	-0.011			
28	-685.985	49.469	-4.002	-3.021			
29	-684.971	-125.312	1.275	0.155			

Figure 27 - Example of the ddf data file type imported into spreadsheet

Given the potentially large quantity of data that the DTS records, the *.ddf files (full data set) can be up to ~800kb in size while the *.dtd files (temperature only) can be up to ~200kb.

© Sensornet 2007

ORYX SYSTEM & LOG FILES

System settings, configuration and log files are stored under the Root directory and also under the DTS System Files and Log directories for each respective Oryx. Most of these files are critical to the correct operation of the ODC software and should not be moved, renamed or deleted. The “Main Log.txt” file (under ‘ROOT’) logs all errors and significant events reported by the Base Unit. The “Oryx system log.txt” is the log file received from the Oryx and tracks errors and significant events on the Oryx device itself. Both of these files are useful in diagnosing faults and should be sent to Sensornet if a fault needs to be reported

SUMMARY OF THE ORYX DTS FILE TYPES

File Type	Type / Location	Purpose
***.ddf	Full Data Set type data file. …\Full Data set\... …\Latest	This file contains the complete distributed temperature sensing data for an installation. The contents of the data file include the raw Stokes and Anti-Stokes data, the optical fibre length information and the temperature at each point along the optical fibre. Header information contains name, date, time software version numbers etc.
***.dtd	Temperature only type …\Temperature only\... …\Latest	Contains distributed temperature sensing data in a compact format. Some header information followed by the start point, the distance step interval and then the temperature data.
***.tdf	Points or Zones data file …\Full Data set\... …\Latest	This file contains the DTS temperature data associated with particular zones that may have been defined.
***.tcd	PT100 Measurements …\Full Data set\...	This file contains the temperature data as recorded by the PT-100 thermometers connected to the DTS system, and the internal reference thermometer
***.xml	Full data set XML file …\Full Data set\... …\Latest	As per *.ddf files but in XML format

© Sensornet 2007

File Type	Type / Location	Purpose
***.raw	Full Data set type. …\Full Data set\...	Contains the raw un-corrected Stokes & anti-stokes data. Potentially useful to Sensornet for trouble-shooting.
***.cfg	Configuration file …\Full data set\ installation\	This file defines the measurement parameters for a specific installation. A new Configuration File is created whenever the Configuration Wizard is run, and whenever the contents of the existing Configuration File are revised. Users are advised not to manually edit this file.
***log.txt	Log file	Text files recording system activity. See text above.
***.ini	Initialisation file	Various files for the configuration of the ODC software. Do not delete or modify.
***.dts	DTS system file	Oryx DTS system files. Do not delete or modify.

The user can select which data file types are saved on the base station (see Figure 13), Sensornet recommends checking the following options: *.ddf data and/or *.dtd data; *.tdf data; *.tcd data and/or WITSML if required. The *.raw files are useful for Sensornet if a fault with the temperature reading occurs.

© Sensornet 2007

GUIDE TO DTS MEASUREMENTS AND THE ORYX CONFIGURATION WIZARD

This section will provide some background to DTS measurements and a guide to the Oryx DTS configuration wizard for correctly setting up the DTS.

BACKGROUND TO DTS

Principle of operation

The Oryx DTS system uses a short optical pulse to illuminate the glass core of an optical fibre. As the optical pulse moves down the core of the optical fibre, it is subjected to different types of radiation scattering.

The majority of the scattered radiation is because of naturally occurring density fluctuations frozen in the glass core and is known as Rayleigh scattering. This type of scattering can provide information on the optical loss of the fibre (as used in an OTDR – Optical Time Domain Reflectometer). This is not sensitive to temperature but must be considered when calibrating a DTS system.

A second type of scattered radiation is known as Raman scattering. Raman scattering occurs when the original optical pulse energy is modified by the molecular vibration modes within the glass core. Changes in the temperature of the fibre cause the energy and the population of these vibration states to change. Light is scattered from the vibrating molecules and as it does so, experience a kind of “Doppler shift”. The scattered particles of light (known as ‘photons’) are shifted slightly in optical frequency. When the optical photons loose energy to the glass, they are down shifted in frequency and are referred to as “Stokes” photons. Conversely when the optical photons gain energy, the frequency is increased and are known as “anti-stokes” photons. Both of these signal photons travel back along the fibre and are detected in the DTS. The ratio of anti-stokes to stokes from a constant optical pulse can be used to calculate temperature. The DTS system uses the anti-stokes to stokes ratio in conjunction with the time of flight of the optical pulse to determine the temperature of the fibre at a given point. The principle of operation is depicted in Figure 28.

The “Raw signal” display in the ODC configuration wizard and in the ODV software, shows these Stokes and Anti-Stokes signals which the user can use for checking fibre cable integrity and losses (this is described in the ODV section, ‘Raw Data Display’ page 82).

© Sensornet 2007

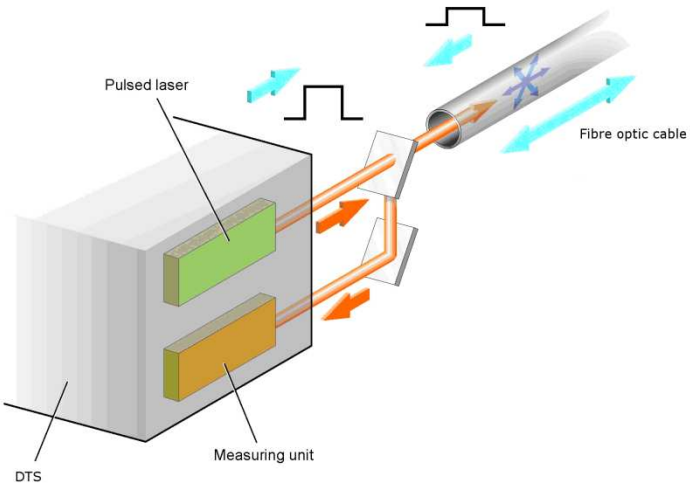


Figure 28 - Principle of DTS operation

Optical Fibre Construction

An optical fibre consists of a cylindrically symmetric strand of glass composed of a central core which is surrounded by an outer cladding (this is known as bare fibre). The core & cladding guide light travelling down the fibre. The Oryx DTS system is optimised to use a 50/125 optical fibre which has a core diameter of 50 microns and a cladding diameter of 125 microns. The bare fibre is surrounded by the primary coating. The primary coating allows the optical fibre to be physically handled while preventing mechanical damage to the central core and cladding. The primary coating is commonly made from acrylate and has a diameter of 250 microns.

The 50/125 optical fibre used with Oryx DTS system is categorised as Graded Index Multimode Fibre. The term ‘graded index’ is used to explain the glass core which is constructed to have a parabolic refractive index gradient which increases smoothly from a uniform value in the cladding to a maximum value at the centre of the core. See Figure 29.

The term ‘multimode’ is used to explain the fact that the optical fibre can guide multiple modes of light along the optical fibre core. This type of fibre gives better signal levels for DTS systems compared to a “Singlemode” optical fibre which is commonly used in telecommunications.

© Sensornet 2007

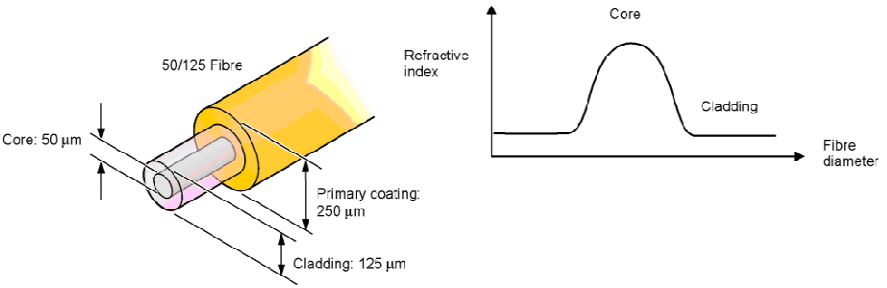


Figure 29 - Typical construction of graded index multimode optical fibre

Signal Loss in Optical Fibres

All optical fibres experience a marginal loss of signal owing to absorption, radiation scattering and reflection. This constant loss along the fibre results in the Stokes and anti-stokes signals showing an exponential decay with distance. Step loss points occur on or around joins (connectors or splices) or breaks in the optical fibre. The overall loss of the signal within a length of optical fibre is expressed by its attenuation coefficient, which is wavelength dependent. The DTS signal loss typically has a value of 1.2 to 1.5dB/km at a wavelength of 975nm. This is the wavelength of the light used in the Oryx DTS system. Signal loss is an important consideration when designing and calibrating an optical fibre sensing network. The known signal losses of the optical fibre are used to optimise the DTS system. See the ODV section on page 82 for more information on measuring losses in fibre cables.

NOTE: The light signal propagates along the optical fibre from the DTS system to the end of the optical fibre and back again. This means the system will experience a 2-way signal loss of approximately 2.4dB/km in good fibre

Effect of Optical Fibre Cable on DTS Operation

It is usually necessary to place the bare optical fibres into cables for protection. These cables offer increased protection from environmental, mechanical and electrical damage and interference. When placing optical fibres in cables, there are a number of factors to consider which will affect the choice of cable to use. These are summarised below.

- The cable will insulate the optical fibre from the environment being measured. This will reduce the response time to fast temperature changes.

© Sensornet 2007

- The cable design can drastically increase or decrease the bend sensitivity of the optical fibre. Increased bend sensitivity can lead to increased noise levels being observed.

- The cable environment & insulation should be considered. If one side of the cable is exposed to a different temperature than that of the other side, the DTS may not accurately record the temperature of the installation being measured.

- The measurable temperature range of the optical fibres can be hampered by the temperature performance of the cable.

For more advice or information on cable selection for specific applications and environments, please contact Sensornet Ltd.

Calibration Parameters

There are several parameters which affect the temperature readings produced by the DTS. These are summarised here and also described in the next section as the user is guided through the Calibration Wizard. These parameters may differ across different fibre types as well as different fibre runs from the same manufacturer. Hence it is necessary to set the parameters on the actual installed sensing fibre to ensure best accuracy. The DTS is calibrated and set with default calibration constants at the factory; however each installation should be checked on-site.

- *Length scaling parameter (dispersion)* - This parameter sets the length scaling of the Stokes signal to match the Anti-Stokes. This is necessary due to the fact that each of these signals travels at slightly different speeds in the fibre. Fibre from different manufacturers may require small adjustment of this parameter.

- *Temperature Slope* – This parameter sets the change in reported temperature along the length of fibre cable. It is required to compensate for the difference in optical loss between the Stokes and anti-stokes signals. (This parameter is not required for a double-ended measurement, please see page 68).

- *Temperature Offset* – This parameter sets the overall offset of the reported temperature trace. This is necessary fundamentally from the scattering and capture efficiency of each signal in the fibre.

GRAPHICAL USER INTERFACE

The Graphical Interface is a sophisticated display tool which the software utilises to display and manipulate the distributed raw & temperature data. The main graphical

© Sensornet 2007

interface is shown in Figure 30 & details of the graphical pallets in the following figures.

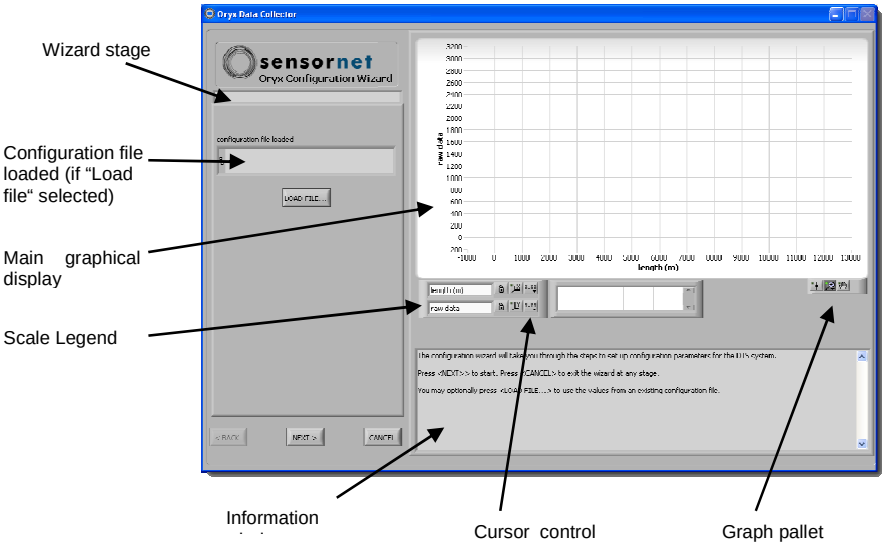


Figure 30 - Elements of the graphical interface

The scale legend pallet, below, identifies the X & Y axes and controls the format of the axes (linear or log etc) and whether the axes are auto-scaling (padlock closed) or fixed (padlock open). To auto-scale each axis one-time only, click the middle axis button, while the padlock is 'open'.

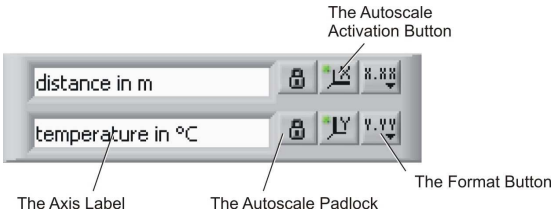


Figure 31 - The scale Legend pallet

Using the cursor control pallet (Figure 32), the user can add and delete cursors and set whether the horizontal & vertical cursors are locked to a displayed trace. If the cursor is locked to a trace, moving either horizontal or vertical cursor will cause the

© Sensornet 2007

opposite line to track the movement on-trace, enabling easy reading of values at a particular distance for instance. Right click to obtain the cursor context menu.

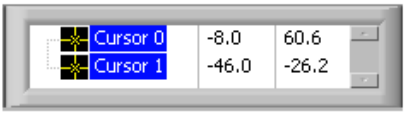


Figure 32 - The Cursor control pallet

The graph pallet (Figure 33) sets the function enabled when the cursor is positioned over graphical area. The cross hair enables cursor actions, the magnifying glass enables zooming and the hand allows panning movement of the trace within the graphical area.

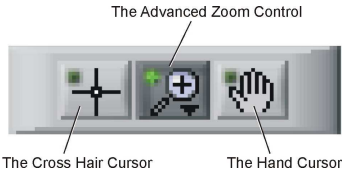


Figure 33 - The graph pallet

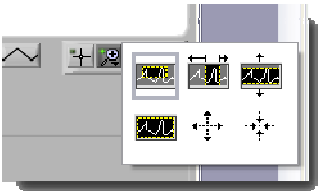


Figure 34 - Zoom functions

The types of zoom functions are shown in Figure 34 and are available when the magnifying glass button is pressed. The options are (left to right, top to bottom):

- Band zoom – user selects a region in both X & Y axis to zoom to
- X zoom – zoom on X axis only

© Sensornet 2007

- Y zoom – zoom on Y axis only
- Full scale – zoom out to show full scale on both axes
- Zoom out – zoom out from cursor position
- Zoom in – zoom in from cursor position

It is also possible to simply double-click the start and end scale legend values on the graphical plot and enter numerical value to more precisely set the scales.

ORYX CONFIGURATION WIZARD

Collecting data

The Configuration Wizard is used to create a new configuration file whenever the Oryx DTS system is connected to a new installation. Configuration files contain important calibration information for an individual installations ensuring the DTS can accurately measure temperature. The DTS system is pre-calibrated for use with common types of 50/125 graded index multimode optical fibre. As such, it is not essential to run the Configuration Wizard but is recommended for fine tuning the system for a specific installation.

To begin the Configuration Wizard, select “Measurement Config Wizard” from the ODC main menu (Figure 16). The user is prompted to select the particular Oryx required and then presented with the first wizard screen to allow an existing configuration to be loaded if required. Select “Load File…” if an existing configuration is to be loaded and modified, otherwise click “Next”. The user is then prompted to enter a name for this configuration (Installation Name) and optionally, any notes associated with this (Figure 35).

© Sensornet 2007

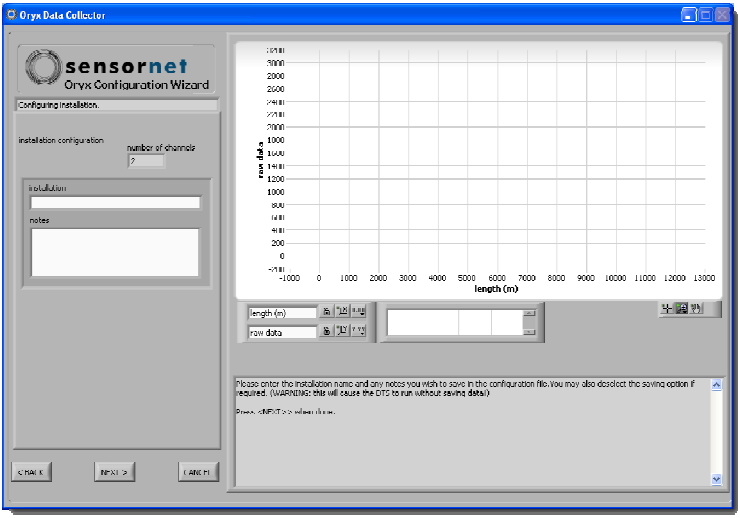


Figure 35 - Installation name screen of the configuration wizard

After entering a name for the installation, each channel can be activated (Figure 36) and set up in turn. If a channel is not activated, the indication button is not illuminated and no further setup of that channel will be processed (the wizard will skip to the next channel).

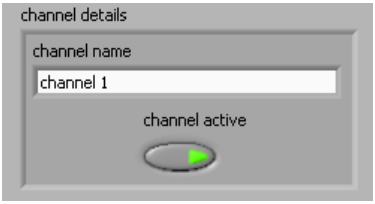


Figure 36 - Channel 1 Activated

The user is then prompted to collect data for a period of time. By default this is 30 seconds but can be increased if a long fibre is connected. Press “Collect Data” to begin.

Once data is available, the Stokes and anti-stokes signals are displayed as shown in Figure 37.

© Sensornet 2007

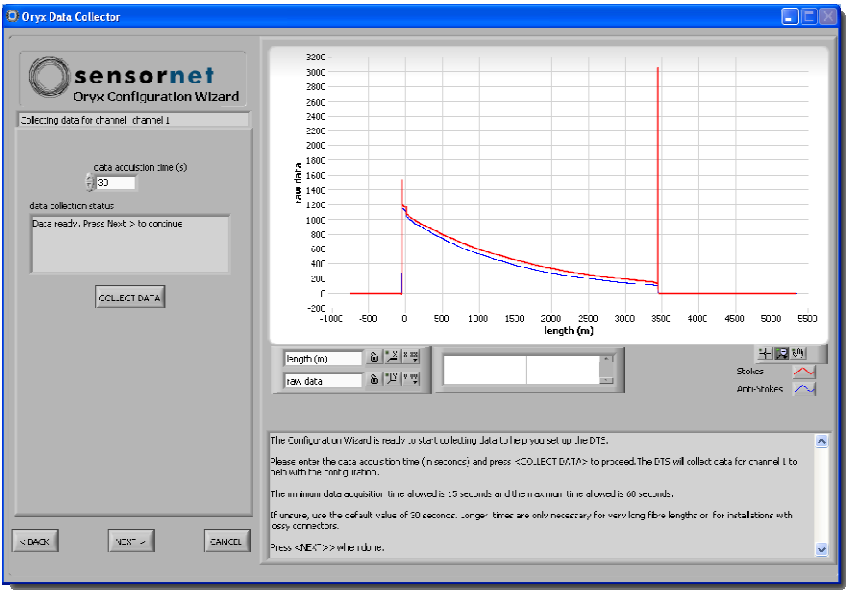

Oryx Data Collector
sensornet
Oryx Configuration Wizard
Collecting data for channel channel 1
data accusition time (s)
30
data collection status
Data ready. Press Next > to continue
COLLECT DATA
< BACK
NEXT >
CANCEL
raw data
length (m)
Stokes
Anti-Stokes
The Configuration Wizard is ready to start collecting data to help you set up the DTS.
Please enter the data accusition time (in seconds) and press <COLLECT DATA> to proceed. The DTS will collect data for channel 1 to help with the configuration.
The minimum data acquisition time allowed is 15 seconds and the maximum time allowed is 60 seconds.
If unsure, use the default value of 30 seconds. Longer times are only necessary for very long fibre lengths or for installations with lossy connectors.
Press <NEXT>> when ready.

Figure 37 - Configuration wizard – data collected

The red & blue traces represent the Stokes and anti-stokes signals respectively. Some key features to note about the raw signal traces are:

- The section from -50 to 0m is the internal reference oven of the DTS
- The zero meter point is at the DTS output connector
- With good, continuous fibre, the traces will show an exponential decay. Point losses and temperature events along the fibre will cause the traces to deviate from a smooth exponential profile
- The end of the fibre will be visible if less than the maximum range
- The background, no light, level should be at zero on the Y-axis

© Sensornet 2007

Length (dispersion) Correction

The next stage of the Configuration Wizard is to perform a length or dispersion correction. The length correction process ensures that the DTS measures the distance along the optical fibre with an optimum spatial resolution. The DTS is pre-calibrated for most common multimode optical fibres but may require fine adjustment. As discussed above, there are two component wavelengths propagating down the optical fibre at the same time. These can be seen on the graphical display as red and blue plot lines. The red plot represents the distributed stokes signal and the blue plot line the anti-stokes signal. Since the two component wavelengths propagate down the optical fibre at different speeds, two group indexes are present in the system. The user should performing a length (or dispersion) correction to align the stokes and anti-stokes traces to a single reference point along the optical fibre. The most common and easily identifiable feature to use as a reference point is the optical fibre end. In most installations the optical fibre length is known (at least approximately) and can be recognised as the point where the signal traces drop to zero on the length axis.

NOTE: The fibre end point may show different features depending on the termination of the fibre. In some cases the signals may simply drop to zero amplitude, in other cases, a spike may be seen due to a larger reflection at the fibre end.

Aligning the stokes trace with the anti-stokes allows the calibration wizard to set the system for optimal spatial resolution. The default settings should be acceptable in most cases, with the user only needing to make fine adjustments.

© Sensornet 2007

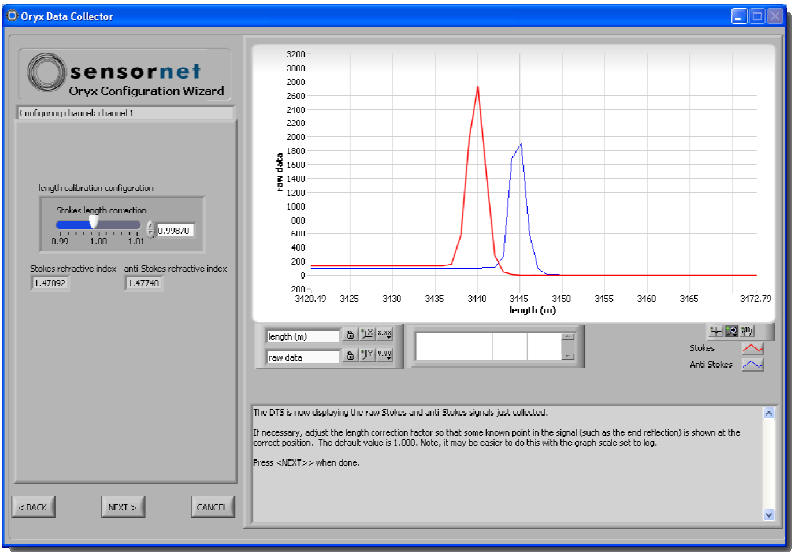


Figure 38 - Length (dispersion) correction incorrect

Figure 38 & Figure 39 show the effect of incorrect and correct settings (use the graphical zoom feature to clearly see the effect of alignment). The adjustment is made by either clicking & dragging the slide control or clicking within the value field (defaults to 1.00000) and using the up and down arrows on the keyboard.

NOTE: Ensure that the autoscale 'padlocks' are not closed when adjustments are made, otherwise the scales will zoom out automatically showing the full trace.

© Sensornet 2007

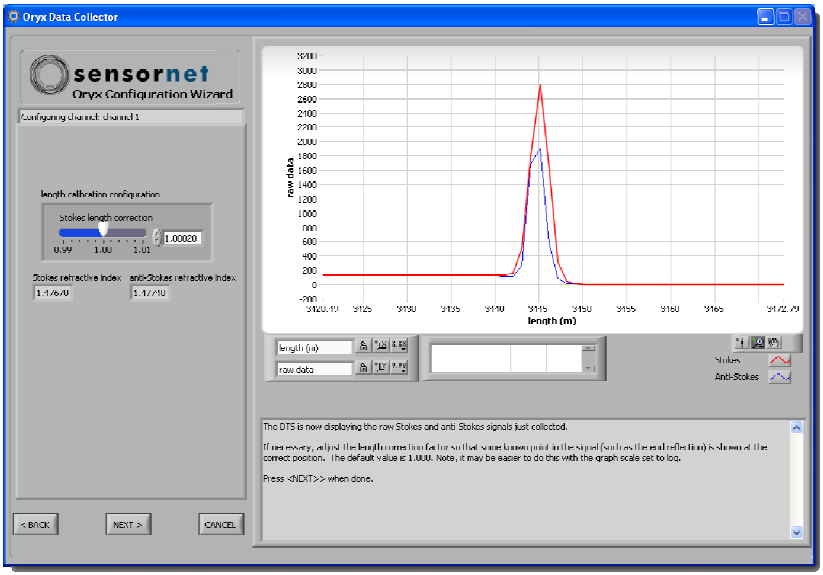

Oryx Data Collector
sensornet
Oryx Configuration Wizard
Configuring Channel: Channel 1
length calibration configuration
Stokes length correction
1.00020
0.99
1.00
1.01
Stokes refractive index
anti-Stokes refractive index
1.47670
1.47470
raw data
length (m)
Stokes
Anti-Stokes
The DTS is now displaying the raw Stokes and anti Stokes signals just collected.
If necessary, adjust the length correction factor so that some known point in the signal (such as the end reflection) is shown at the correct position. The default value is 1.0000. Note, it may be easier to do this with the graph scale set to log.
Press <NEXT>> when done.
< BACK
NEXT >
CANCEL

Figure 39 - Length (dispersion) correction correct

Setting the Measurement Range

The next screen allows the user to specify the measurement range. The maximum fibre length is measured by default but the user can reduce the range to avoid unnecessary data being collected (and reduce data transfer times). Temperature data beyond the end of the fibre typically appears as very large amplitude noise (-200 to +700℃). The graphical zoom buttons can be u sed to zoom in on the end of the fibre or end of the region of interest to help set the maximum measurement range.

Differential loss correction – Single ended

The next stage is to set the method of ‘differential loss’ correction. This is required to correct for the slightly different loss in the fibre of the Stokes signal compared to the anti-stokes signal which may vary from fibre to fibre. For a continuous length of fibre at constant temperature, this differential loss correction appears to affect the slope of temperature vs. distance (hence it is referred to as ‘slope correction’). In this section, single-ended correction will be assumed (i.e. only one end of the fibre connected to the DTS). For the alternative ‘combined’ or ‘double-ended’ correction, please see section 0, page 68.

© Sensornet 2007

Leaving the differential correction method set as ‘single-ended’, click ‘Next’.

Temperature Slope Calibration

Three methods of setting the slope correction are provided:

- Fixed value
- Matched sections
- Temperature reference sections

Each of these is described below.

Slope Calibration – Fixed Value

In this case the user manually adjusts the slope calibration value to obtain the correct slope of the temperature trace. This is easily done for fibre at constant temperature along its length but can also be done if two sections of fibre are known to be at the same temperature. This works best if the two sections are widely separated from each other. The graphical display will update ‘live’ as the slope value is adjusted using the slide control or the numerical value is modified. See Figure 40.

NOTE: The absolute value, or offset, of the temperature trace does not need to be correct at this stage. This is corrected for in the next section:- Offset correction.

The user should zoom into the temperature trace to an appropriate scale. The original temperature trace is shown in grey and the trace calculated with the new slope setting, is shown in white.

© Sensornet 2007

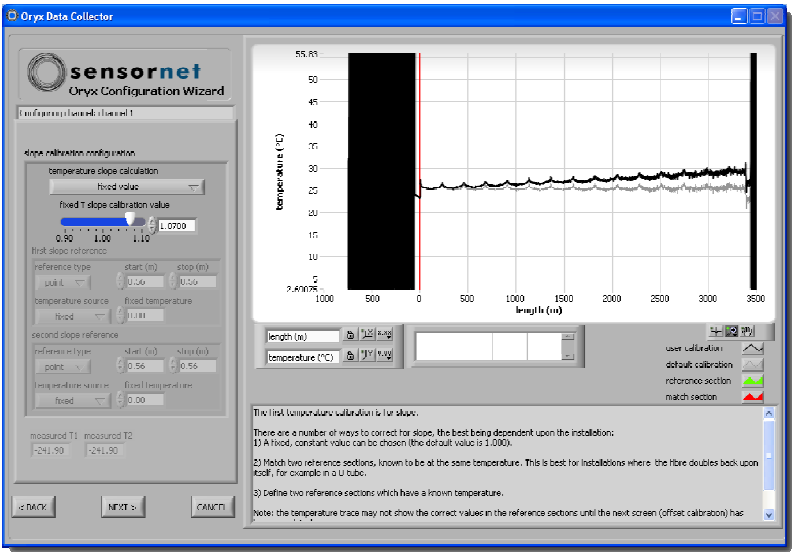


Figure 40 - Slope calibration – fixed value

Slope Calibration – Matched Sections

If matched sections are selected from the slope calibration drop down menu, the user will be required to enter the distance values for the start and end points of two zones or sections. As described above for the fixed value case, these matched sections should be known to both be at the same temperature, or known to be physically co-located such that the temperature profile over the sections is the same. The software will then automatically calculate the slope calibration value. See Figure 41.

The two sections of fibre chosen will be highlighted by green and red bands. The software will ensure that the calculated slope value sets the average temperature within these bands to be the same.

NOTE: The absolute value, or offset, of the temperature trace does not need to be correct at this stage. This is corrected for in the next section:- Offset correction.

© Sensornet 2007

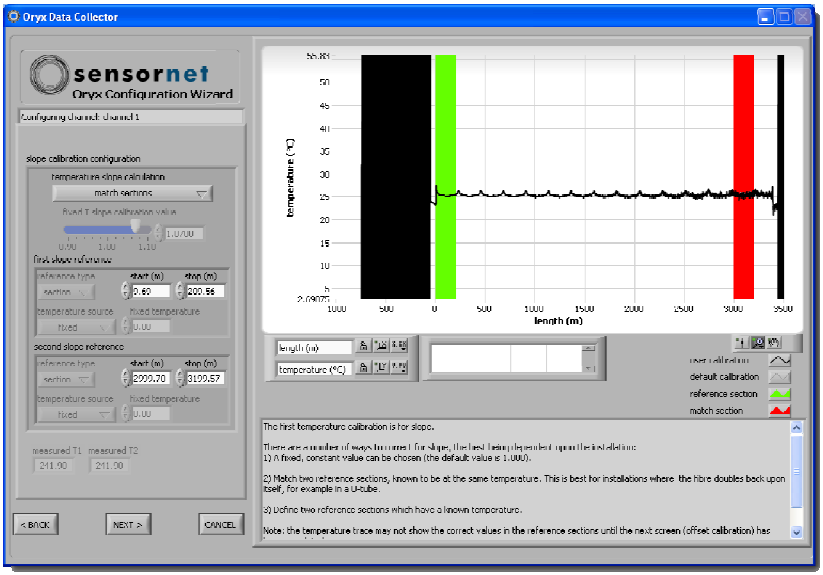


Figure 41 - Slope calibration – matched sections

Slope Calibration – Reference Sections

This method of slope calibration is a development of the matched sections discussed above. The user is required to enter the distance values for two fibre sections but now each section can be at a different temperature. The user can select two methods for defining what the temperature of each section is:

- Select 'Temperature source' to be fixed. In this case the user enters the temperature of each section into the 'fixed temperature' field.
- Select 'Measured T1/T2' as the source. The software will now assume that the external PT100 probe supplied is positioned within the section of fibre specified and calculate the slope calibration appropriately.

NOTE: Again, the actual temperature values of the DTS trace may not be correct. It is only important that the slope is corrected for at this stage.

Please see Figure 42 as an example of this setting.

© Sensornet 2007

The user can also specify a single point in the fibre as a reference instead of a zone or section. This may be more appropriate if independent measurements or the PT100 probe is used to measure only a short section (<2m) of fibre.

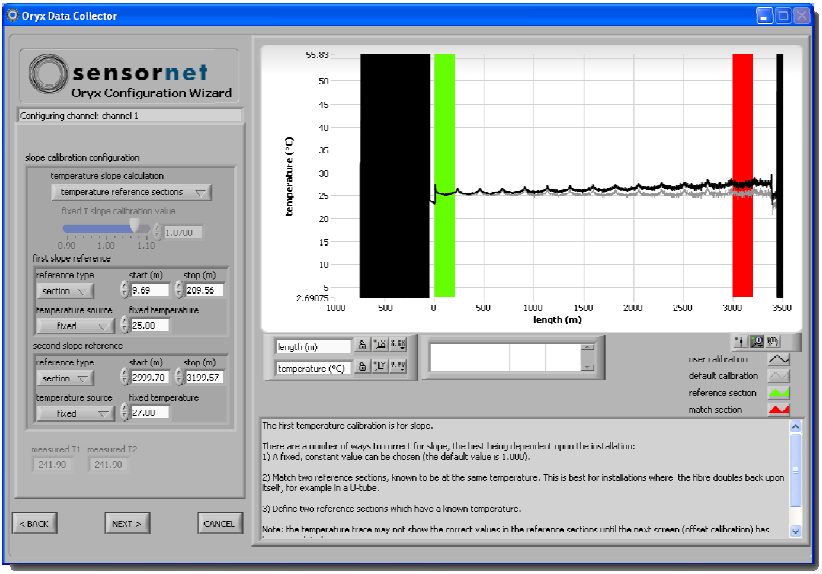


Figure 42 - Slope calibration – reference sections

Click ‘Next’ to proceed to the next stage.

Temperature Offset Calibration

The temperature offset calibration is similar to the slope correction but now the absolute temperature reading of the DTS is calibrated. As for the slope correction, the user can choose between a ‘fixed value’ correction, or use a reference point or section of fibre.

In Figure 43, reference section has been selected as the calibration method and the offset reference has been selected as ‘Point’ (800m entered) with the temperature source as ‘Fixed’, specifying the temperature at this point to be 25℃. The temperature source can also be selected to use one of the measured PT100 probes.

NOTE: Only one reference section or point is required to set the offset calibration.

© Sensornet 2007

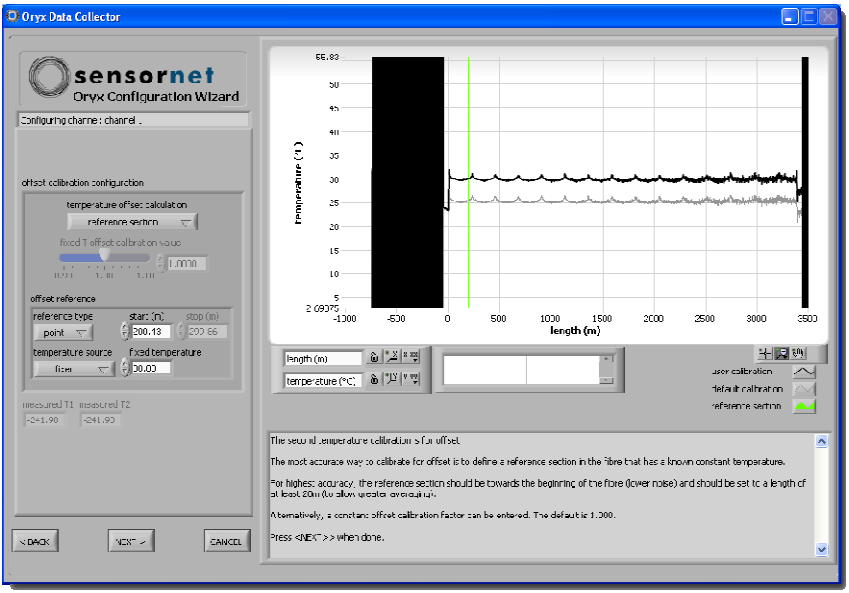


Figure 43 - Offset correction – point reference type selected

Setting the calculation method

Once the offset calibration is complete, if any of the calibration options have been set as 'matched sections' or 'reference section' the user will be presented with a screen to set the method of the calibration calculation (Figure 44). The two options are 'Dynamic' and 'Fixed' and can be set independently for slope and offset calibration.

- *Dynamic* – in this case the calibration coefficient used will be calculated *every measurement.* Hence the coefficient may change from trace to trace.

- *Fixed* – in this case the calibration coefficient calculated during the setup wizard will be fixed and used for all calculations of temperature data traces

In most cases, it is recommended to set the method to 'fixed' so that the calibration coefficients will not change from measurement to measurement. However, in certain cases, for example in harsh environments where the fibre properties may change, dynamic method may be appropriate. (In this case however a 'combined' or double-ended measurement may be appropriate).

© Sensornet 2007

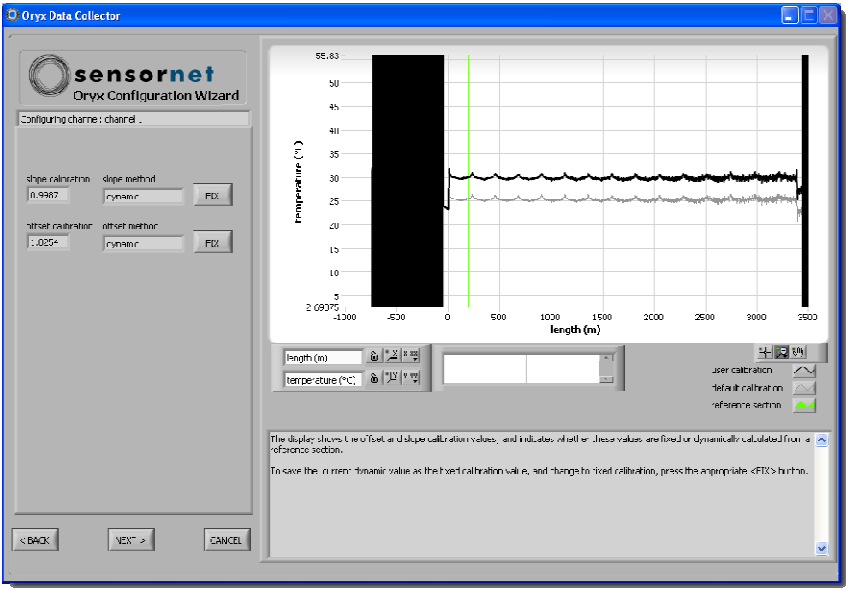


Figure 44 - Setting the method of slope and offset calculation

Once the method has been selected, click ‘Next’ to proceed.

Adding Zones

The user is presented with the option to add ‘zones’ or regions of the fibre cable which can be monitored for average, maximum, minimum or variance (maximum minus minimum) temperature.

Click on the “Add zones…” button to define the zones required. Enter a zone label (name) and the start and end points as shown in Figure 45. The temperature trace can be zoomed to clearly view any particular region of interest and the zone is highlighted. Click the “Add zone” button to define the zone and add it to the list. Once all zones have been defined, click “OK”. The user will then see a list of the defined zones and each is highlighted on the graphical display (Figure 46).

The temperature data associated with each zone is logged in the files with extension *.tdf.

© Sensornet 2007

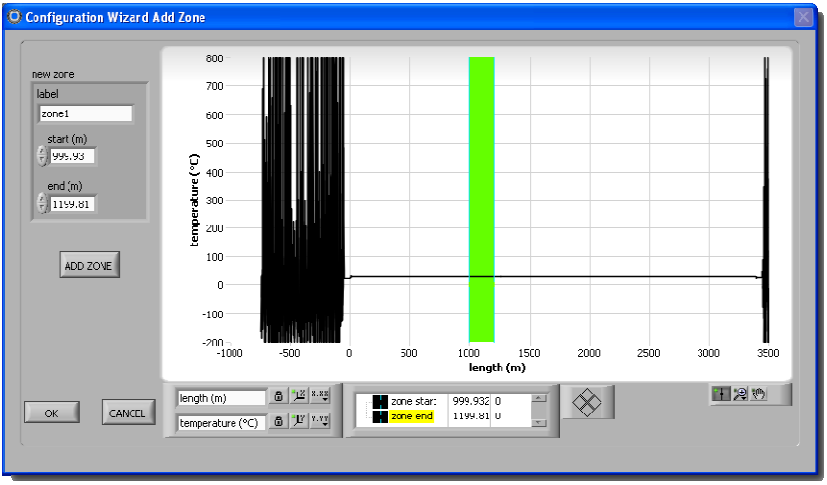


Figure 45 - Setting a zone

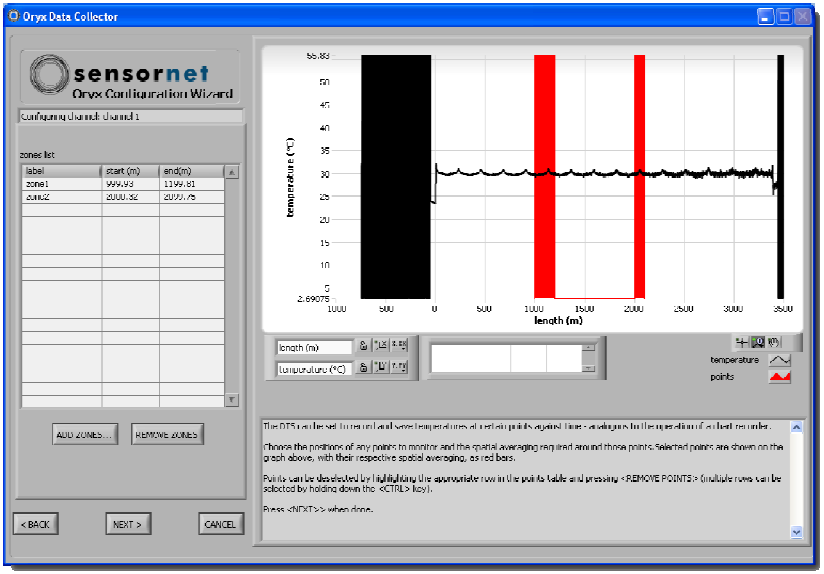


Figure 46 - The list of defined zones

© Sensornet 2007

Click ‘Next’ to proceed.

Setting the Spatial Averaging & Measurement Time

The user is then prompted to set the spatial averaging and measurement time. The spatial averaging does not affect the way the DTS takes measurements but simply combines a certain number of adjacent measurement points into one data point by calculating the mean of those temperature points. The effect of this is to reduce the measurement noise (point-to-point variations) but reduces the spatial resolution (smoothing of features along the fibre). The default value is the minimum spatial averaging allowed by the system – no point-to-point averaging. This minimum spatial resolution is determined by the pulse duration of the laser and the sampling period of the data acquisition system.

The measurement time is the time taken to collect data, average the signals on-board and transfer to on-board memory. During most of the measurement time, the laser will be active and repeated firing (or triggers) of the laser are recorded. These signals are averaged on-board to reduce the noise on the final temperature data trace and improve the temperature resolution. Hence, longer measurement times will reduce the noise and improve the signal-to-noise ratio.

NOTE: The noise reduction follows an inverse square-root law with measurement time – i.e. to reduce the noise by a factor of 2; the measurement time needs to be increased by a factor of 4.

For very short measurement times, <30s, a portion of the time is used for transferring the data to memory. (The exact period of data transfer time depends on the range selected).

It may be important to ensure the measurement time is short enough to capture any thermal changes in the system being monitored but also, long enough to reduce the noise to acceptable levels and resolve small temperature differences.

Further Channel setup

Following the spatial averaging and measurement time screen, the user is prompted to configure other channels in a similar manner if required. If other channels are not required, simply leave the channel de-activated.

Repetition Time & Number of Measurements

The next screen is where the user defines the repetition time and whether the DTS should measure continuously, or record only a set number of measurements and then stop (Figure 47).

© Sensornet 2007

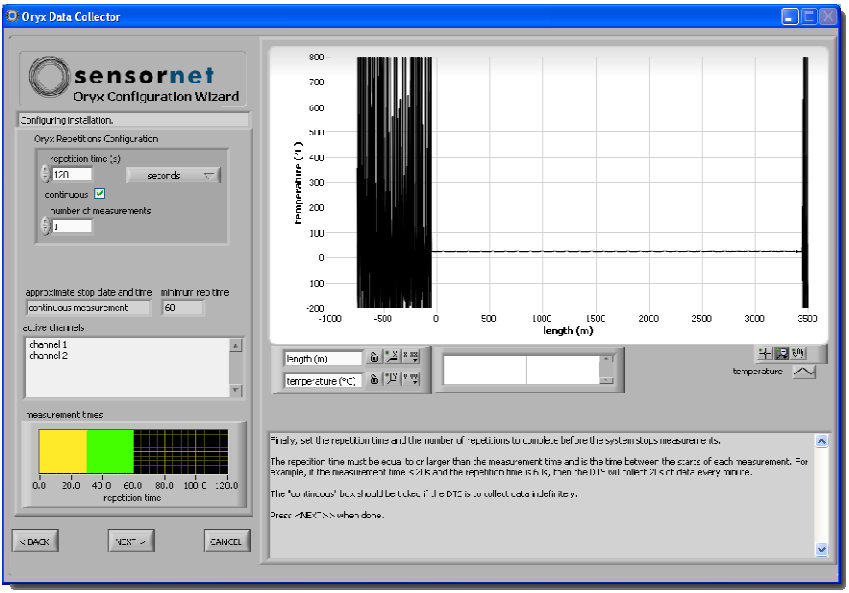

Oryx Data Collector
sensornet
Oryx Configuration Wizard
Configuring installation.
Oryx Repetition Configuration
repetition time (s)
120
seconds
continuous
number of measurements
1
approximate stop date and time
minimum rep time
continuous measurement
60
active channels
channel 1
channel 2
measurement times
0.0 20.0 40.0 60.0 80.0 100.0 120.0
repetition time
< BACK
NEXT >
CANCEL
Temperature (°C)
length (m)
Finally, set the repetition time and the number of repetitions to complete before the system stops measurements.
The repetition time must be equal to or larger than the measurement time and is the time between the starts of each measurement. For example, if the measurement time is 2 s and the repetition time is 5 s, then the DTS will collect 2 s of data every minute.
The "continuous" box should be ticked if the DTS is to collect data indefinitely.
Press <NEXT> when done.

Figure 47 - Setting the Repetition time and number of measurements

The repetition time is the time taken for one complete measurement cycle and includes the measurement time for each channel and any idle time. For example in Figure 47, two channels are configured to measure for 30 seconds each with an idle time of 60 seconds and then the cycle repeats. This gives a repetition time of 2 minutes. The repetition time can be set in seconds, minutes, hours or even days.

To enable the Oryx to log temperature traces continuously, ensure the box is ticked. Otherwise, enter the total number of measurements to be taken before stopping.

NOTE: The minimum repetition time allowed will be equal to the sum of measurement times for all active channels.

Uploading the Configuration

On clicking next, the user is prompted that all data on-board the Oryx will be deleted when the configuration is uploaded (data already downloaded to the PC is unaffected). The start time of the first measurement can be specified or selected “as soon as possible” (see Figure 23). Because of the time taken to communicate with the Oryx and upload the configuration, there may be a delay of up to one repetition period before the first measurement takes place.

© Sensornet 2007

This completes the configuration wizard setup and the user is returned to the main menu to begin collecting data from the Oryx.

© Sensornet 2007

DOUBLE-ENDED MEASUREMENTS

INTRODUCTION TO DOUBLE-ENDED

As briefly discussed on page 57, an effect known as 'differential loss' within the sensing fibre can affect the calibration accuracy of any DTS system and needs to be corrected for. Differential loss refers to the slightly different loss (or attenuation) in the fibre between the Stokes and the anti-stokes signals. In good fibre optic cable, this loss difference is constant along the length of the fibre and the effect can be corrected for using a straight forward 'slope correction' as described on page 58.

There are two specific cases were the differential loss may not be constant along the whole length of the fibre cable:

1. If there are connectors or severe bends in the fibre line. Loss at these points is sometimes unavoidable and furthermore, the loss may be different for each of the Stokes and anti-stokes signals. This point-like differential loss results in an artificial temperature step at the connector or bend point.

2. If the fibre is subject to harsh environments where there is the possibility of hydrogen ingress. This can cause the attenuation of the fibre to change and again, the change may be different for the Stokes and anti-Stokes signals. Generally the change in attenuation only occurs in the exposed region and other parts of the fibre are unaffected.

The effects described above will result in the differential loss changing along the length of the fibre, in one case at a definite point, in the other, over an extended region of fibre.

In both cases, the effect can be corrected for by using what is known as a combined or double-ended measurement. This relies on both ends of the fibre being connected to the DTS and a measurement is taken from each end of the fibre before a temperature profile is calculated.

As long as both ends of the fibre optic cable can be connected to the DTS, a double-ended measurement can be performed. The fibre cable can be routed around an installation and reconnected to the DTS (the fibre does not retrace its path) or, two fibres may be inside one cable with a splice to join the ends such that the fibre physically retraces its path back to the DTS (so-called 'U' installation).

NOTE: It is not necessary for the fibre to physically retrace its path for double-ended method to work.

© Sensornet 2007

In the case of two fibres in one cable, the physical range of the DTS system is halved, since the effective *fibre* length is twice the *cable* length. 0 shows an example double-ended 'U' type installation with typical appearance of the temperature traces recorded from either end of the fibre and the combined result.

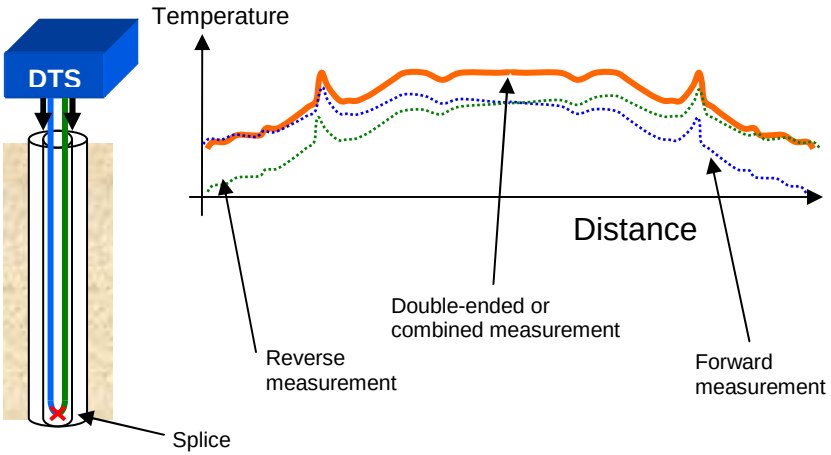


Figure 48 - Double-ended measurement with 2 fibres in one cable

The double-ended measurement will correct for static and evolving changes in the fibre for every measurement. There are two main differences this method introduces to the DTS measurement compared to the single-ended method:

- The physical range of the DTS is halved, since both ends of the fibre must connect to the DTS
- The noise performance (temperature resolution) is degraded at each end of the fibre but best in the middle of the fibre. This is a consequence of combining the measurements from each end of the fibre.

CONFIGURING A DOUBLE-ENDED MEASUREMENT

A double-ended measurement should be configured only by using the configuration wizard within the ODC. Ensure both ends of the fibre optic line are connected to the DTS, forming a single measurement loop. (Two such loops can be used with the 4

© Sensornet 2007

channel version). Click the “Measurement Config Wizard” button on the ODC main menu (Figure 7) and follow through the procedure up to the differential loss configuration screen.

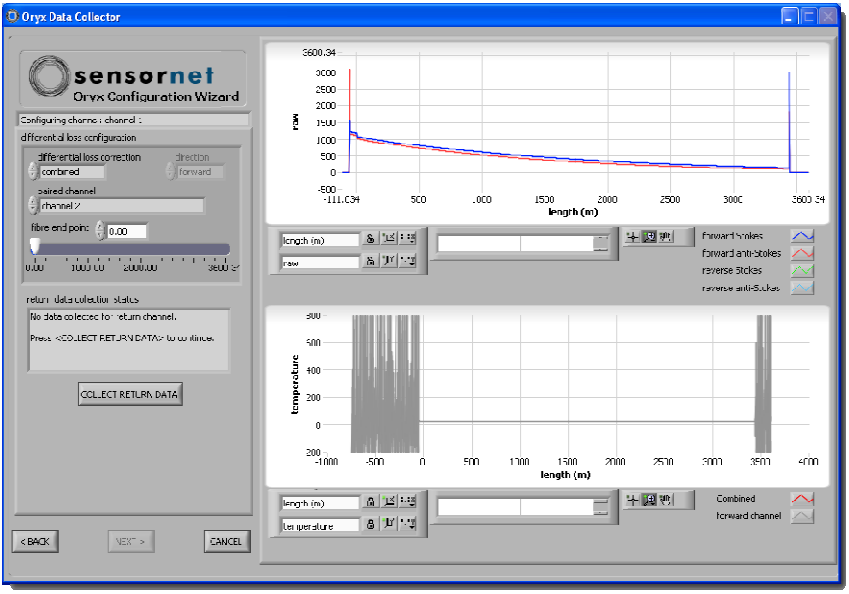


Figure 49 - Combined (Double-ended) measurement selected for differential loss correction.

Select “Combined” as the differential loss correction and then select the appropriate channel which will be ‘paired’ with the current channel to take the reverse DTS measurement (Figure 49). Click “Collected Return Data” to measure the fibre loop from the opposite end.

Referring to Figure 50, the upper graphical plot will now show four traces, the Stokes and anti-Stokes from each end of the fibre. (Only part of the reverse traces may be displayed at this point). The lower plot shows two temperature traces, the white plot is that calculated from the first, forward measured data (single ended) and the red plot is the temperature trace calculated from the combined or double-ended data. The combined temperature trace will most probably be incorrect at this stage because the ‘fibre end point’ setting is not correctly set.

© Sensornet 2007

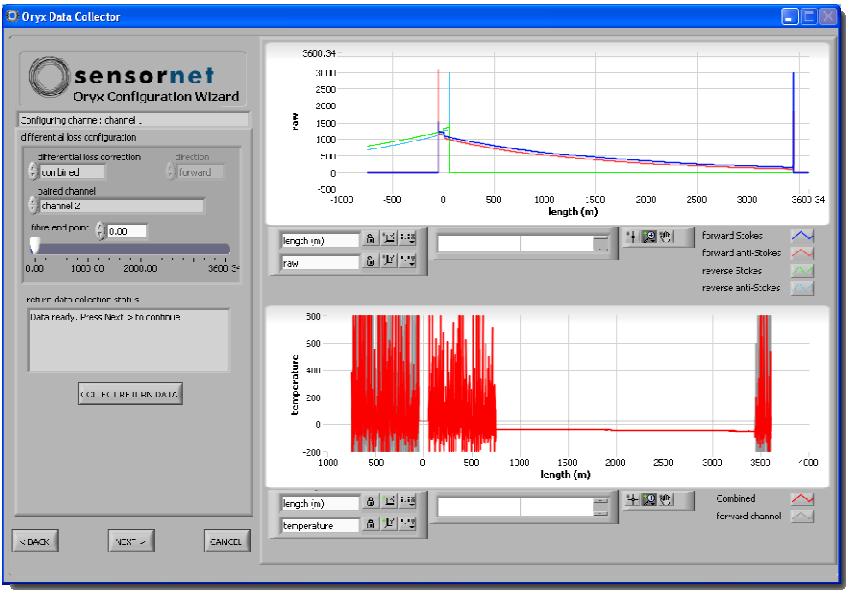


Figure 50 - Forward and reverse data collected

Setting the Fibre End Point

The end point of the fibre now needs to be defined in order to correctly align the forward and reverse signals. Using the graphical zoom functions, expand the scale on the upper, raw data, display and the lower temperature display to clearly see the region around the end of the fibre. A useful guide would be to have the length scale show about 150m to 200m at the end of the traces. See Figure 51.

Since the very last ~50m of fibre is the internal reference section of the Oryx DTS, the actual *fibre cable* end position is approximately 50m less than the point at which the raw data signals drop to zero. This point is the connector at the output of the DTS and can typically been seen on the raw data traces as a small drop in signal (due to the connector loss) or, a small spike due to a reflection. An example of this is clear in Figure 51, upper plot. The lower temperature plot may also show an anomaly at the same connector position. The position of this connector should be used as the setting for the 'fibre end point' and can be entered (typed) directly into the numerical field.

In Figure 51, the end point has been set at 3392m.

© Sensornet 2007

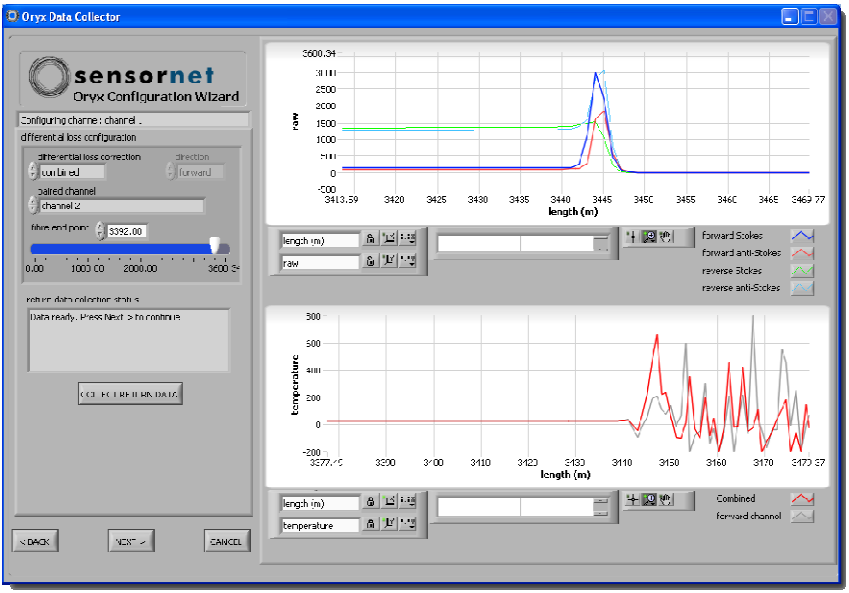


Figure 51 - Setting the fibre end point

Once this is done, the reverse raw data signals will start and end at exactly the same positions on the length scale – see Figure 52. The combined (red) temperature trace should show a sensible reading, although some deviation from the single-ended calculation (white trace) will be apparent especially if there are fibre connectors, splices etc. in-line or there are different types of fibre connected together.

NOTE: An easy way to begin the alignment is to adjust the 'fibre end point' value until the forward and reverse raw signals line up at the start and end of the traces. (Figure 52)

In the case of a fibre loop formed from two fibres in one cable ('U' installation), the combined temperature trace will be symmetrical about the cable centre point, as shown diagrammatically in 0. Due to the splice or bend at the end of such a cable, it is also usual to observe a small spike (either up or down) at the centre point. This feature can be used to accurately align the forward and reverse traces. The 'fibre end point' value should be adjusted to make the spike feature as narrow as possible (this may not be the smallest amplitude however).

© Sensornet 2007

NOTE: Other features along the installed cable can also be used to align the forward and reverse traces. Choosing a feature near the centre of the cable will ease this process since the signal levels are approximately equal at this position.

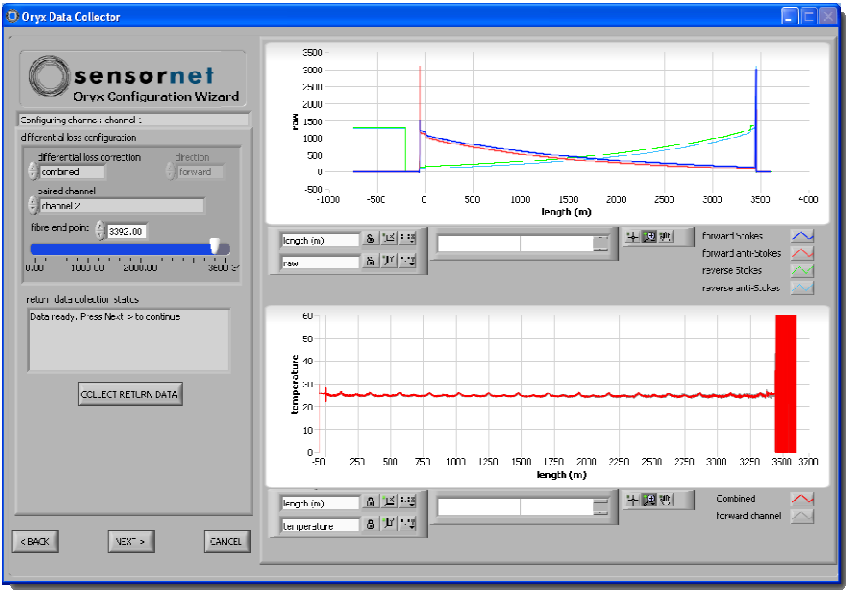


Figure 52 - Forward and reverse traces aligned

This completes the double-ended part of the configuration and on clicking ‘Next’, the user is prompted to set the offset correction and follow through the rest of the setup as for the single-ended case, page 61.

Once setup is complete & the configuration has been uploaded to the Oryx, exit to the main menu to begin collecting data.

© Sensornet 2007

THE ORYX DATA VIEWER

The Oryx data viewer (ODV) is used to view both the current (last measurement taken) and historical DTS temperature traces recorded by the Oryx. This section provides information on installing and using this software.

NOTE: The user cannot modify any settings on the Oryx DTS using this software. Use the ODC software to change settings and configuration

SOFTWARE INSTALLATION & LICENSING

The ODV software should be installed by inserting the CD and running the setup.exe file under the ODV directory. (If installing a new version, please uninstall the old version first). The user is recommended to accept the default directories and options presented.

The ODV software is licensed on a per-computer basis. If a license has not been purchased, a free 10 day trial is allowed. Once this has expired, a licence key will be required for further use. During the trial period, the user may click on the splash screen displayed at program start (Figure 53) to enter the license configuration screen.

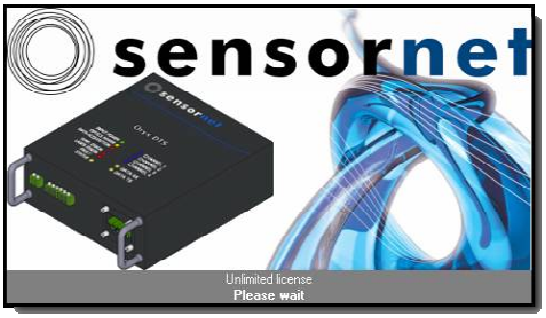


Figure 53 - The ODV splash screen

NOTE: If a laptop or base station server has been purchased from Sensornet, the ODV will already be installed and license activated.

In order to activate the software with an unlimited license, please install the ODV and send Sensornet the “Site Code” as displayed in Figure 54 below.

© Sensornet 2007

Oryx Data Viewer - License Configuration
Program License Help
Program not authorised
Site Code: 5014 8673 7162 2320 91
Site Key
Validate
Sensornet oryx Data Viewer
You can use this software for a trial period of 10 days. Please contact Sensornet to obtain a product key to unlock it for further use. You will have to provide Sensornet with the site code as well.
Sensornet Ltd.
sales@sensornet.co.uk

Figure 54 - License configuration

Sensornet will then send a “Site Key” which should be entered to validate the software.

Transferring the license

The ODV license may be transferred from one PC to another. A USB memory stick or similar is needed to do this. Click on the splash screen to enter the license configuration window. Then select the menu item “License->Transfer out…”. You will be prompted to specify the drive of the USB memory stick or other removable drive. Then take this removable drive to the new computer and install the ODV. Enter the license configuration window on this computer and select “License->Transfer in…”. Ensure the correct drive is specified in the dialog box and click Finish. This completes the license transfer and the ODV should start normally, if it does not, select “Program->Resume Program execution”.

SETTING ROOT & SELECTING AN ORYX

The first time the ODV is run, the user will need to specify a ROOT directory. This is the top level directory underneath which all Oryx data and configuration files are stored and should be the same as that for the ODC software. In this case the user is presented with the dialog shown in Figure 55.

© Sensornet 2007

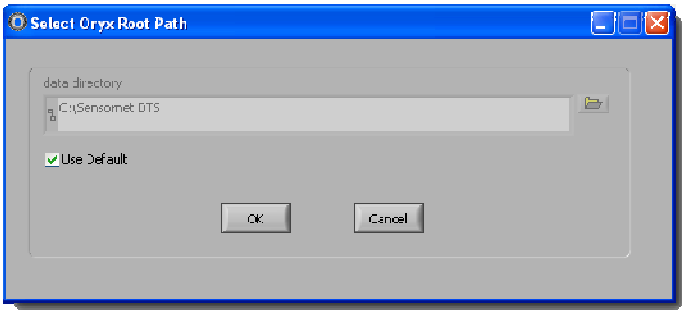


Figure 55 - Setting the ODV ROOT path

Clicking on the folder icon, allows the user to browse for a folder. Once the browse window has the desired folder open (i.e. the folder you wish to use as root is open and displayed in the “look in” field) click the button “Current Folder” (see Figure 56).

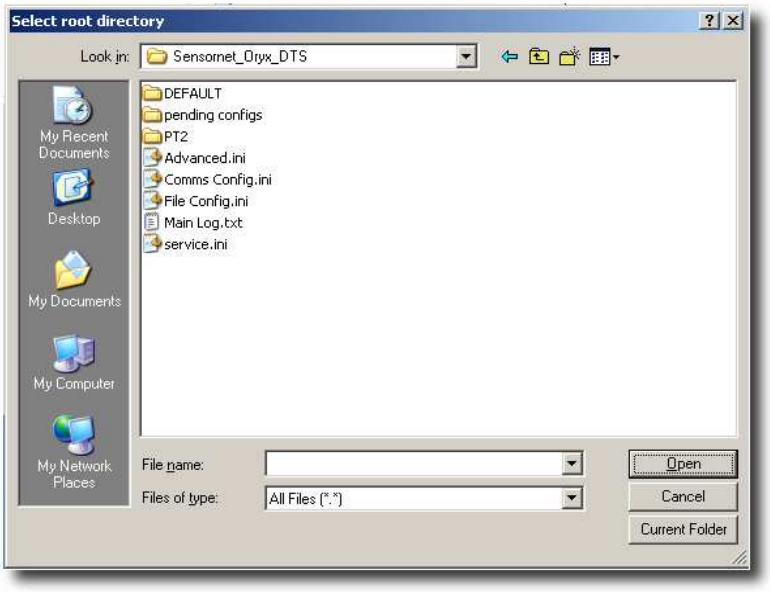


Figure 56 - Example of ROOT directory. Click “Current Folder” to select ‘Sensornet_Oryx_DTS’ as the root

© Sensornet 2007

On clicking “Current Folder” to set the root directory, the user is presented with the main graphical view shown in Figure 57. This defaults to showing “Current” data – i.e. the last data trace downloaded.

To the left of the main graphical area are the menu items and information panels. The version number of the software is displayed near the top of the window, under the Sensornet logo.

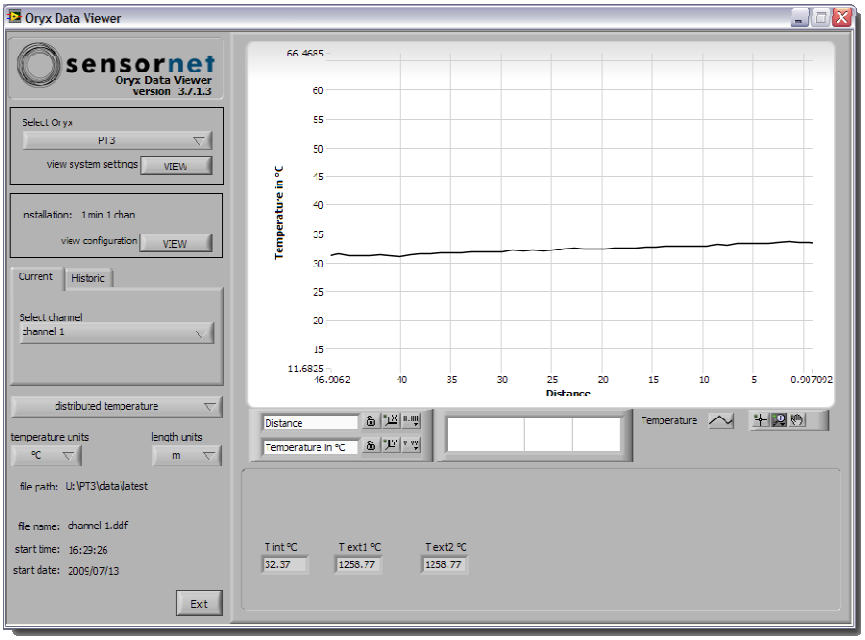


Figure 57 - The ODV main view

The data from different Oryx devices may be viewed from within the ODV. All the Oryx devices connected to the base unit will be displayed in the “Select Oryx” drop-menu from where one device can be selected (Figure 58). Clicking the “view system settings” button enables the Oryx factory settings to be viewed which may be useful for trouble-shooting by Sensornet. These settings cannot be altered by the user.

© Sensornet 2007

NOTE: Although multiple Oryx units may be connected, data from only one Oryx at a time may be viewed with the ODV.

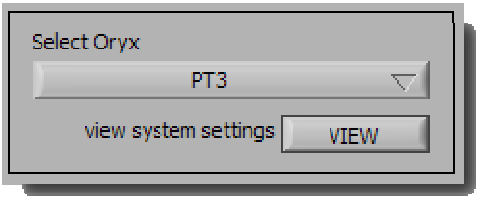


Figure 58 - selecting an Oryx for data view

VIEWING LIVE DATA

Once the root directory has been set and the desired Oryx selected using the menu in Figure 58, the display defaults to showing the most recent data downloaded from the Oryx (see Figure 57). When viewing current data, the ODV will display the data as soon as it is collected by the Oryx Data Collector.

NOTE: The 'current' data is only the most recent set of data downloaded from the Oryx DTS by the ODC. This might not be the latest data actually on-board the Oryx due to, for example, connection problems between the base unit and remote Oryx device.

The installation information (Figure 59) shows the name of the current installation (or configuration) and the "View configuration" button, allows the settings for that configuration to be seen. This displays the details of the configuration but the values cannot be changed.

NOTE: The configuration settings are specific to each installation and can only be changed from within in the Oryx Data Collector (ODC) software.

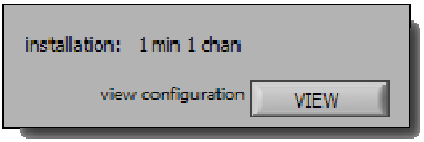


Figure 59 - The Installation panel

© Sensornet 2007

Please see the section on the Oryx configuration wizard, page 52, for a description of the individual configuration settings.

The data from each channel may be viewed individually using the selection menu shown in Figure 60. Historical data may also be viewed by clicking on the “Historical” tab – viewing historical data is described in the next section.

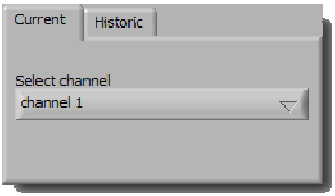


Figure 60 - Current data – channel select

The type of data displayed can be selected using the drop-down menu below the channel selector; the options are shown in Figure 61.

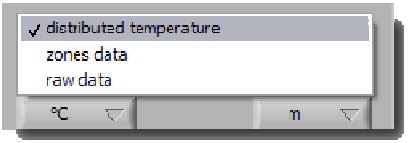


Figure 61 - Selecting the display type

A description of the features associated with each of these displays is given below. Immediately below the display type selector are two drop-down menus that allow the user to select between SI (Meters, Centigrade) or Imperial units (Feet, Fahrenheit) of measure. SI units are used by default and regardless of the display selection, only SI units are saved to disk.

© Sensornet 2007

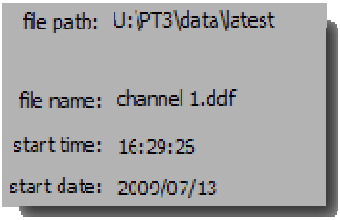


Figure 62 - Displayed file details

Just below the units selection, are displayed some details about the data file that is currently being displayed (file path, name, measurement start time & date). These details are automatically updated as new data arrives (see Figure 62).

The different display types are now described:

Distributed Temperature Display

This is the main temperature display (see Figure 57), showing temperature recorded along the fibre optic cable. The user can pan, zoom in/out and move cursors on the temperature display by clicking the appropriate button on the graphical control pallet (Figure 33). For more information, please see the section on the graphical user Interface, page 49 & on.

NOTE: Previous zoom and pan actions can be un-done by holding down Cntrl-Z.

Below the main plot area, three display fields show the recorded temperatures of the DTS internal temperature (Tint) and the external PT100 resistance probes (Text1&2).

© Sensornet 2007

Zones Data Display

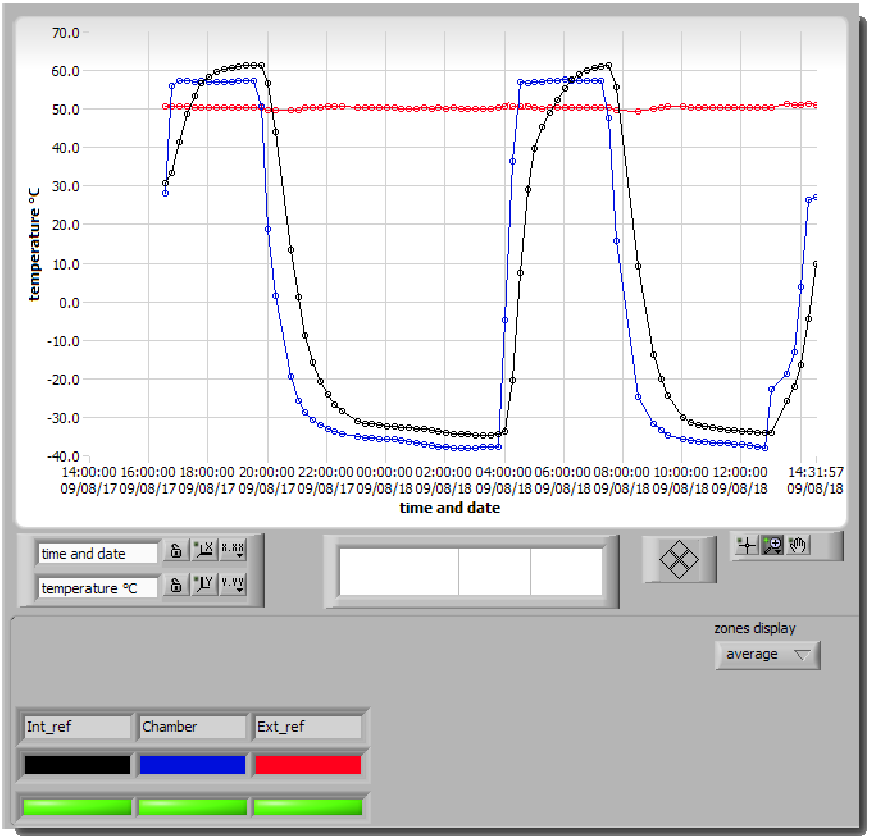


Figure 63 - The Zones data display

When “Zones data” is selected, the temperatures of any defined zones are displayed as a function of time (zones are defined within the ODC). The user can select to display the average, maximum/minimum & variance (max minus min) of the temperature within each zone. The colour of each trace can be changed by clicking on the coloured bar for each zone and traces can be individually toggled on-off by clicking the green bar at the bottom. The display will update as new data arrives.

© Sensornet 2007

If the autoscale ‘padlocks’ are closed, the plot will automatically scale correctly for new data.

Raw Data Display

This display shows the Stokes and anti-Stokes signals generated by the DTS. These raw signals are very useful for checking the quality of the fibre optic line and roughly measuring the losses along the cable and at joins in the fibre. An example of this display is shown in Figure 64. For a fibre cable at constant temperature along its length, the signals show the classical exponential signal decay. Also note the step loss at the zero meter point, this is the connector loss at the DTS output.

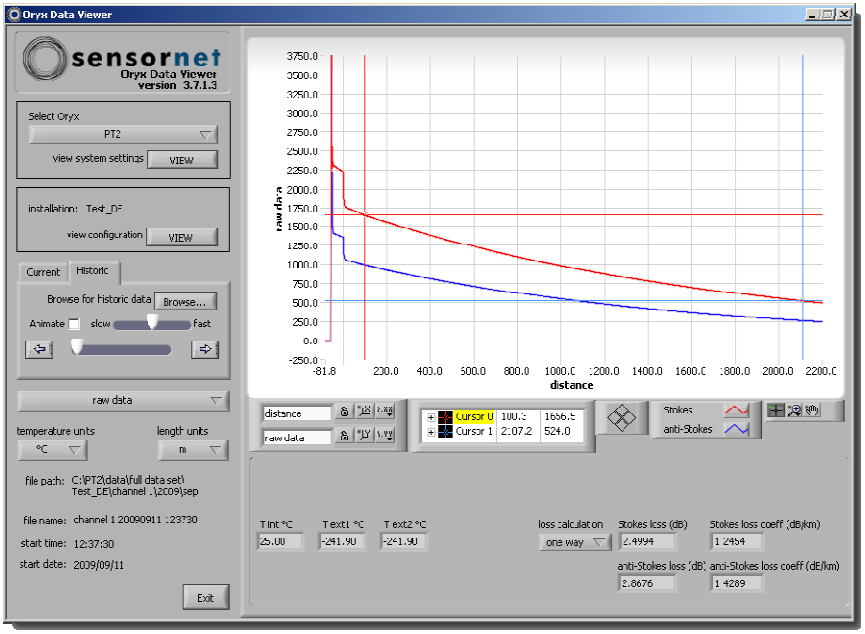


Figure 64 - The Raw data display

Cursors can be added to the plot (right-click on the cursor display field & select: Create Cursor->Free) to measure the approximate loss. Two cursors should be added (they do not need to be ‘snapped’ to a particular trace) and positioned by selecting the cursor control button on the graph pallet (Figure 33). In Figure 64 above, the cursors have been positioned at approximately 100m and 2107m. The loss calculation is performed on the signals at these cursor locations. Although the

© Sensornet 2007

DTS signals propagate both ways along the fibre, it is convention to record and specify losses on a one-way basis. As seen in the figure above, the measured loss of the fibre cable in this measurement (for Stokes) is approximately 2.5dB total (between the two cursors) or 1.24dB/km (which is typical for good fibre at the DTS wavelength).

NOTE: If comparing the fibre loss measured with the DTS against an OTDR for example, please bare in mind the different wavelengths.

NOTE: Although both Stokes and anti-Stokes loss values are reported, it is recommended that the Stokes loss value is used as a good indication of the fibre, splice or connector loss since this parameter is much less temperature sensitive.

To measure the loss of a connector or splice, simply zoom in on the feature and position the cursors immediately either side of the signal drop.

NOTE: An increase or decrease in temperature at any position in the fibre will cause an increase or decrease in both the anti-stokes and (to a lesser degree) the Stokes signals. Hence the loss values recorded will be most accurate when there is little temperature difference at the two cursor positions.

VIEWING HISTORICAL DATA

Viewing historical data using the ODV is similar to that described above for the current data. The main differences are that the user can select any “installation” name, or configuration, and load multiple files for animation play-back as a kind of time-lapse view.

Figure 65 - Historic data selection

© Sensornet 2007

First ensure the correct Oryx is selected and then click the “Browse” button to load data. The user is presented with the window shown in Figure 66 From here, the desired installation (configuration) name, channel, year etc can be selected. Click “Load Day Data” to select files from the particular day specified. This brings up the dialog window shown in Figure 67. Highlight the files to be included and click “Add” or “Remove” as appropriate.

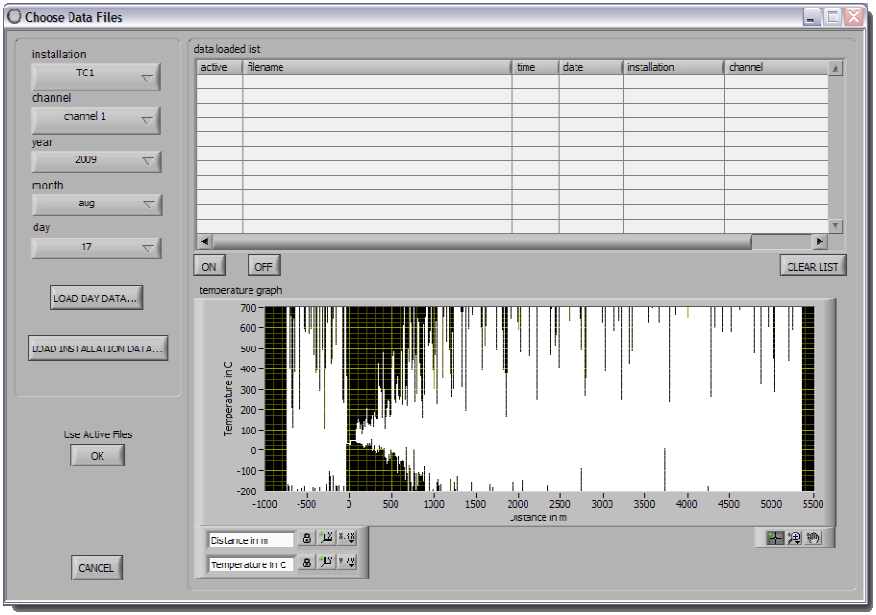


Figure 66 - Choosing the data files to display in ‘Historic’ mode

NOTE: Ticking the “Add to previous data” check box, will allow different day or month data to be loaded at the same time. Otherwise added data will simply replace the currently selected data.

Click ‘OK’ to return and then ‘OK’ again to use & display the active files. The user may then step through the files in sequence using the arrow buttons (Figure 65) or animate automatically (check the “Animate” check-box) at a variable rate.

© Sensornet 2007

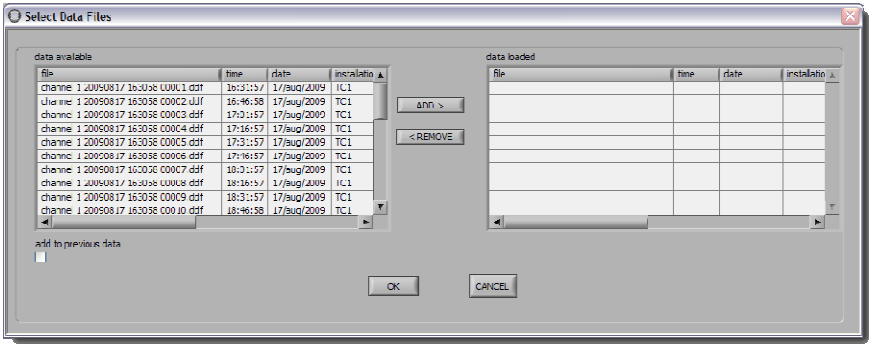


Figure 67 - Selecting data files

The “Load Installation Data” button (Figure 66) will load all data associated with the particular installation name selected – i.e. over all months and all channels. Please be aware that this could be a significant number of files and severely slow the computer.

© Sensornet 2007

CARE & MAINTENANCE

The Oryx DTS is designed for low maintenance operation. There are no moving parts inside the DTS[1] and user maintenance is limited to cleaning of the optical connectors.

External connectors should be cleaned before insertion into the Oryx. Specialist connector inspection microscopes are useful for verifying that connectors are clean and free of foreign material. Video inspection scopes can also be used to view the condition of connectors. There are two methods for cleaning connectors and couplings recommended. The technique used is dependent on the type of contamination. If the connector has been exposed to slight dust contamination, the preferred method is using a 'cassette style' cleaning tape. If the connector has been exposed to grease, lint free tissues wetted with alcohol or pre-soaked wet wipes should be used.

WARNING! UNDER NO CIRCUMSTANCES SHOULD CONNECTIONS BE INSPECTED WHILE THE DTS SYSTEM IS LIVE AND OPERATING.

Please take great care when cleaning the connectors on the inside of the Oryx. The fibre optic connector panel can be removed by unscrewing the four knurled thumb screws and carefully removing the panel. There is sufficient slack on the inside fibre pigtails to allow removal and cleaning.

CAUTION! If one of the internal optical connectors is damaged, the unit will need repair at Sensornet. Only remove the Optical Connector Panel if a dirty connector has been inserted or the optical connector loss cannot be reduced by cleaning the external connector.

The uniters may also be cleaned by blowing clean air through to dislodge particles.

[1] The only exception to this is the MEMs based optical switch.

© Sensornet 2007

TROUBLESHOOTING

Problem	Checks / Corrective Action
Measurements not taking place	- Check reported on-board temperature is within limits - Check supply voltage is within limits (reported in main log) - Check laser temperature within limits (reported in Oryx system log) - Check all 'Power' LEDs are illuminated during a measurement - Check Main log and Oryx system log for other errors
Temperature trace has excessive noise or does not read correctly to the end of the fibre	- Clean connectors - Re-splice fibre joints - Check cable run for sharp bends / breaks - Check fibre types use in cable run - Point losses and a fiber break can easily be identified from the raw signal display. Typical connector loss = 0.3dB Typical fusion splice loss = 0.1dB (one way)
Temperature trace exhibits step changes at fibre joints	- Clean connectors - Re-splice fibre joints - Use double-ended method
Unstable calibration – temperature trace jumps excessively after each measurement Incorrect slope or offset on temperature trace	- Check reference sections have been chosen appropriately. Avoid reference sections across a temperature step - Try using fixed calibration constants - Clean connectors
Error saving data / writing to file or disk	- Ensure there are no spaces at the end of Installation or Channel names - De-select read only permissions for all files and folders in C:\Sensornet DTS and all files and folders in the Oryx ROOT folder - ODC should be run under administrator privileges
No communications with Oryx	- Check PC serial com port settings (Oryx default: 115200b/s; 8bit; 1 stop bit; no flow control - Check Oryx COM port settings

© Sensornet 2007

Problem	Checks / Corrective Action
	- If using Serial-Ethernet server, check virtual com port software - Check modem settings if connected - Connect Oryx direct to serial port of computer - Re-scan for Oryx devices (Probe Com port, Figure 12) - Check power supply to Oryx
Frequent communications errors	- Reduce baud rate on Oryx & rescan for Oryx - If using modem/router, check line quality or signal strength
COM port not listed on computer	- Check virtual COM port software application lists the COM port & is active - Re-boot computer
Oryx date-time incorrect	- Re-boot computer and then synchronise the Oryx date-time

Should a fault need to be reported to Sensornet, please include the following (if possible):

1. The Oryx serial number
2. A full description of the fault
3. An example *.ddf file of good data before the fault occurred
4. Example *.ddf and *.raw files with the fault occurring
5. The “Main log.txt”
6. The “Oryx System Log.txt” from the Oryx in question
7. The current configuration file (*.cfg) located in “…/Full Data Set/<name>”

© Sensornet 2007

SPECIFICATIONS

PERFORMANCE SPECIFICATIONS

Performance measured with the Oryx DTS at 25℃ ambient temperature unless otherwise specified. Sensornet Ltd reserves the right to modify these specifications at any time.

Parameter	Unit	Value		Comments
		SR	XR	
Measurement time	s	≥15	≥30	No upper limit
Temperature accuracy	℃	+/-0.5		Note 1, 3
Max optical loss	dB	7	4.5	Note 2
Maximum Range	km	5.3	12	
Max fibre length	km	12.5		Note 2a
Temperature resolution	℃	Refer to www.sensornet.co.uk for latest spec.		
Temperature range	℃	-200 to 600		Note 5
Sampling period	M	1		
Spatial Resolution	M	2		Note 4
PT100 temperature range	℃	-50 to +250℃		
PT100 accuracy	℃	+/-0.25		-200 to +200℃; Note 6
RTC accuracy	Min/Yr	+/-4		-40 to +65℃ Note 7
Battery lifetime	Yr	15		Note 8
Fibre type	50/125 µm graded index multimode			Note 9

© Sensornet 2007

NOTES:

1. -10℃ to +150℃. Temperature accuracy can be imp roved dependent upon calibration at installation.
2. Optical loss based on Stokes OTDR measurement from the DTS internal reference oven. Includes 0.3dB for optical connector loss. (One way losses quoted).
2a. This is the absolute maximum fibre length which may be connected to the DTS. Gross temperature inaccuracies may result if the fibre length exceeds this value.
3. Preliminary.
4. 10-90% level of a temperature step of 20℃.
5. Dependant on cable
6. 1/5DIN probes, 6mm diam. x 50mm with standard temperature coefficient of 0.00385℃$^{-1}$. 4 wire connection.
7. +/-1min/yr over 0 - 40℃. Leap year adjustment t o 2100. No on-board daylight savings adjustment.
8. Typical expected lifetime ~10yrs at 70℃; ~17yrs at -40℃.
9. 62.5µm fibre may be used with reduced performance.

OPERATING & PHYSICAL SPECIFICATIONS

Optical				
	Unit	Model		Comments
		SR	XR	
Wavelength	nm	975	1550	
Average output power	mW	<1.5	<2.5	Note 1
Frequency	kHz	<8.5		
Pulse energy	nJ	<150	<350	
Optical ports		2	4	Option

© Sensornet 2007

Communications / Output		
Item	**Details**	**Comments**
Serial	RS232 x2	Defaults: 115200b/s; 8 data bits 1 stop bit; No parity
Max cable length	3m	
On-board storage	32MB	Equivalent to ~600 measurements at full range
Ext. Modem	GSM / GPRS / Radio / Satellite	Optional
Ext. Serial-Ethernet server	External serial server required. Virtual COM port software required on PC	Optional

Environmental					
		Unit	Min	Max	Comments
Ambient operating Temperature	SR	℃	-40	+65	Note 2
	XR		-5	+65	
Storage		℃	-50	+80	Note 3

© Sensornet 2007

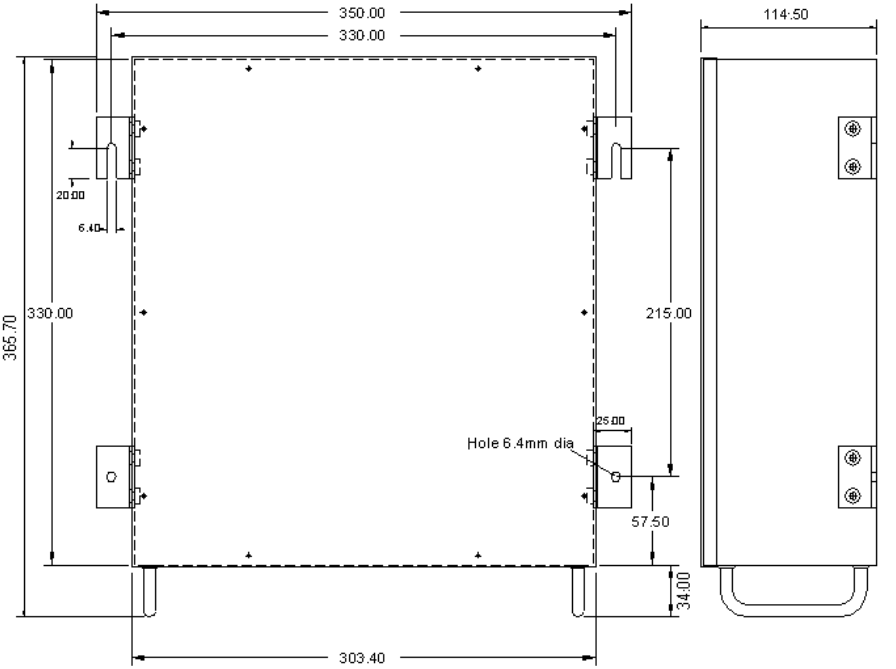
Electrical (All models)					
		Unit	Min	Max	Comments
Supply voltage		V DC	11	26	Measurements are suspended if outside this range
Supply voltage (absolute limits)		V DC	5	26.8	System shutdown outside this range. Note 5
Power-on current surge	SR XR	A	1.5 (24V),2.5 (12V) 3 (24V), 6 (12V)		
Power consumption (Active)	SR XR	W		18 24	Note 4, 4a
Power consumption (Idle)		W	0.5		Initiated if idle period >1min

Weight & Dimensions					
	Unit	Width	Length	Height	Comments
Size	mm	303.5	365.7	114.5	Excl. mounting brackets (See figure below)
Weight	kg	7			

NOTES:
1. All models are Class 1M Laser products.
2. 95% RH max. non-condensing.
3. When moved between places of differing temperature, the Oryx DTS should be allowed to reach ambient temperature before measurements are attempted.
4. SR-15.8W power draw at 22℃ ambient, 18W at temp erature extremes. Excludes any communications module
4a. XR-19.2W power draw at 22℃ ambient, 24W at tem perature extremes. Excludes any communications module
5. Within this supply range, communication with the Oryx is possible to retrieve system status etc.

© Sensornet 2007

DIMENSIONS



WARRANTY

The Oryx DTS is guaranteed against manufacturing defects for one year from date of purchase. Should there be a fault with the system, please contact Sensornet Ltd for assistance.

© Sensornet 2007

This page intentionally blank

© Sensornet 2007

Sensornet Ltd (Head Office)
340 Centennial Park
Elstree
Hertfordshire
WD6 3TJ
United Kingdom

T: +44 (0) 20 8236 2550
F: +44 (0) 20 8236 2551

For more information and further worldwide offices please visit our website at
www.sensornet.co.uk

sensornet

BE THERE

© Sensornet 2007